CIVIL ENGINEERING

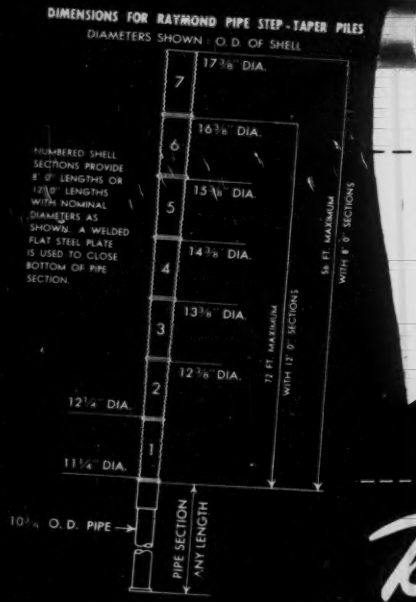
AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

Raymond

MAKES 5 TYPES OF CONCRETE PILES

1. STANDARD . . . 2. STEP-TAPER . . . 3. PIPE STEP-TAPER
4. COMPOSITE . . . 5. GOW CAISSONS

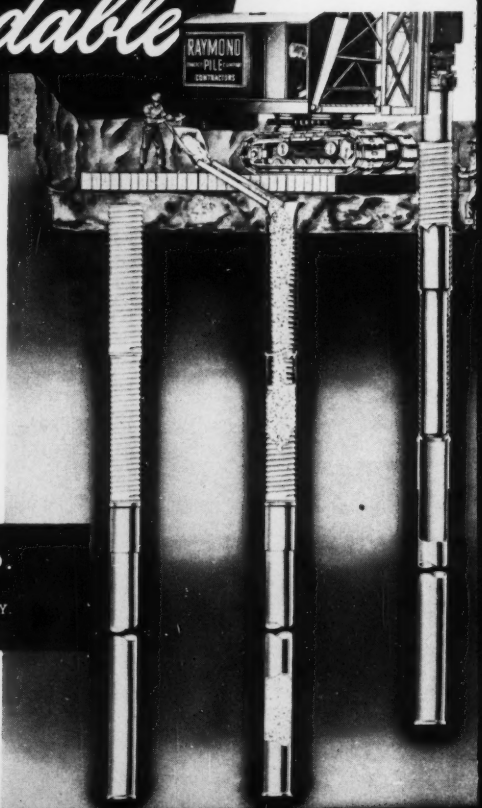
Raymond installs every type of pile: cast-in-place concrete, precast concrete, steel pipe, wood and H-beam. Raymond operations include underpinning; borings and soil investigations; waterfront construction and harbor and river improvements; shipbuilding facilities; also cement-mortar lining of water, oil, gas and chemical pipelines, 4" to 144" diameters, by Centriline Corporation, a Raymond subsidiary.


DIMENSIONS FOR RAYMOND PIPE STEP-TAPER PILES
DIAMETERS SHOWN O.D. OF SHELL
NUMBERED SHELL SECTIONS PROVIDE 8'-0" LENGTHS OR 12'-0" LENGTHS WITH NOMINAL DIAMETERS AS SHOWN. A WELDED FLAT STEEL PLATE IS USED TO CLOSE BOTTOM OF PIPE SECTION.
7
6
5
4
3
2
1
17 3/8" DIA.
16 3/8" DIA.
15 3/8" DIA.
14 3/8" DIA.
13 3/8" DIA.
12 3/8" DIA.
12 1/4" DIA.
11 1/4" DIA.
10 3/4" O.D. PIPE
PIPE SECTION ANY LENGTH
72 FT. MAXIMUM WITH 12'-0" SECTIONS
56 FT. MAXIMUM WITH 8'-0" SECTIONS

3. PIPE STEP-TAPER PILES

Deep and Dependable

At the right, the pipe step-taper pile is being driven with the rigid steel mandrel. In the center the shell and pipe are being filled with concrete after having been driven to satisfactory resistance and inspected. At the left is a completed pipe step-taper pile.



Raymond Pipe Step-Taper Piles are composed of an upper section of Step-Taper Shell Pile and a lower section of closed-end steel pipe pile. These piles are generally used to penetrate thick beds of soft soil to reach hard bottom at depths as great as 150 feet or more. The pipe step-taper pile is a most dependable pile available for reaching hard ground at great depths.

Raymond's methods result in efficiencies and substantial savings that are well worth investigating. Consult our engineers for more detailed information.

RAYMOND PILES MAINTAIN DRIVING RESISTANCE

Raymond CONCRETE PILE CO.

140 CEDAR STREET, NEW YORK 6, N. Y.

BRANCH OFFICES: Boston, Syracuse, Philadelphia, Baltimore, Washington, Pittsburgh, Atlanta, Miami, Houston, Kansas City, St. Louis, Cleveland, Chicago, Detroit, Salt Lake City, Portland, San Francisco, Oakland, Los Angeles and principal cities in Latin America.

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A World of Information about Open Steel Meshes . . . and yours for the asking.

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For more than 44 years the Wm. F. Klemp Company has pioneered in the development and manufacturing of open steel meshes for all industrial applications. Their complete line includes open steel and aluminum grating and treads, ganister lining reinforcement meshes, open steel and aluminum bridge deckings. For the best, most economical answer to your flooring, pipe and vessel lining problems, consult with Wm. F. Klemp Company, 6610 South Melvina Avenue, Chicago 38, Illinois.

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Dear Sir: Please send me, without obligation, the catalogs checked:

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- ☐ Klemp Acme Floor-Steel
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- ☐ Klemp Hexteel (Ganister Lining Reinforcement Mesh) for Catalytic Crackers
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KLEMP, world's largest manufacturer of open steel meshes

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Difficult Suburban Sewer Problem Solved with *CONCRETE PIPE*

THE ALEWIFE BROOK conduit project in the town of Arlington and the cities of Cambridge, Somerville and Medford, just north of Boston, posed an unusual construction problem that was solved with concrete pipe.

The installation of this difficult, trunk-line sewer required that pipe be placed in open-cut street crossings, in tunnels under streets, playgrounds and a railroad, along Alewife Brook which is generally well below the existing water table and finally under the bed of the Mystic River.

In crossing the river, the line was installed as an inverted siphon. This 230 ft. crossing was made by diverting the river to one side and installing two-thirds of the section then diverting the water back over that part of the line already installed.

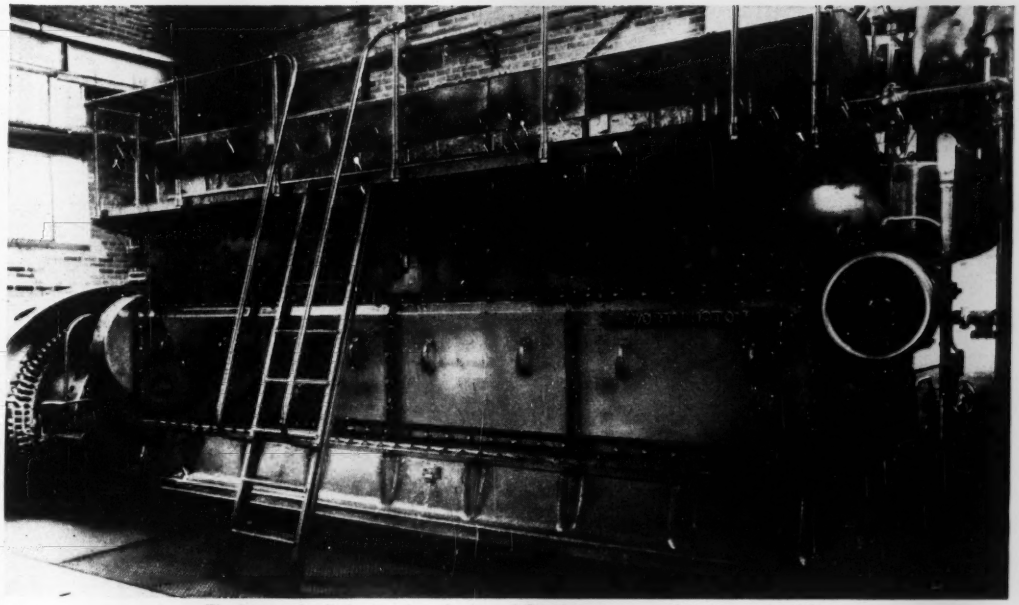
The project required approximately 8300 ft. of 60-in. and 66-in. (ASTM specification C76, Table I and Table II) reinforced concrete pipe using in each case two rows of circular reinforcing steel.

This is but another example of the adaptability of concrete pipe. In addition, it has (1) structural strength to resist severe impact and to sustain heavy overburdens, (2) rugged durability proved by many decades of heavy-duty service, (3) tight joints and uniformly dense structure to insure minimum infiltration and leakage, (4) smooth interior surfaces which provide maximum hydraulic capacity and resistance to abrasion from suspended matter.

Concrete pipe is moderate in first cost, requires little or no maintenance and lasts much longer. The result: ***low-annual-cost*** sewer service.

AMERICAN CONCRETE PIPE ASSOCIATION

228 NORTH LA SALLE STREET, CHICAGO 1, ILLINOIS



Worthington 8-cylinder 4-cycle turbo-charged Diesel engine—one of the two operated by Elko-Lamoille Power Company. This 1000 Kw-rated engine was installed on the same foundation originally built for an engine with 250-Kw rating.

Lesson in Cost Reduction

FROM THE MIDDLE OF THE DESERT

If you've never heard of Elko, you'll find this story interesting.

Elko is the seat of a county in Nevada that, all by itself, is larger than Massachusetts, Connecticut and Rhode Island together, with Delaware thrown in. Since pioneer days, it has been a transportation and trading center.

Elko's present power plant set-up, which includes two four-cycle turbo-charged Worthington Diesel engines connected to 1000-Kw generators, contrasts with the single 50-hp steam engine purchased second-hand in 1896 from a nearby silver mine.

Cost of power has never been more reasonable. Ever since 1940 when fuel oil cost this plant less than half what it does now, power rates have *gone down*—having been reduced twice during the period. Today, 87% of the power is produced by the two Worthington units, and in 1950 the plant averaged 13.3 Kw-hrs per gallon of fuel.

Lubricating oil consumption is low, too—well below the estimated 4,000 rated horsepower hours per gallon.

Want more evidence that there's *more worth in Worthington?* Write Worthington Pump and Machinery Corporation, Engine Division, Buffalo, N. Y.

WORTHINGTON

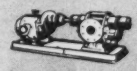
E.1.11

ECONOMICAL CONTINUOUS POWER

Diesel Engines, 150 to 2640 hp
Gas Engines, 190 to 2880 hp
Dual Fuel Engines, 345 to 2640 hp

WORTHINGTON-BUILT AUXILIARIES

Balanced Angle Compressors

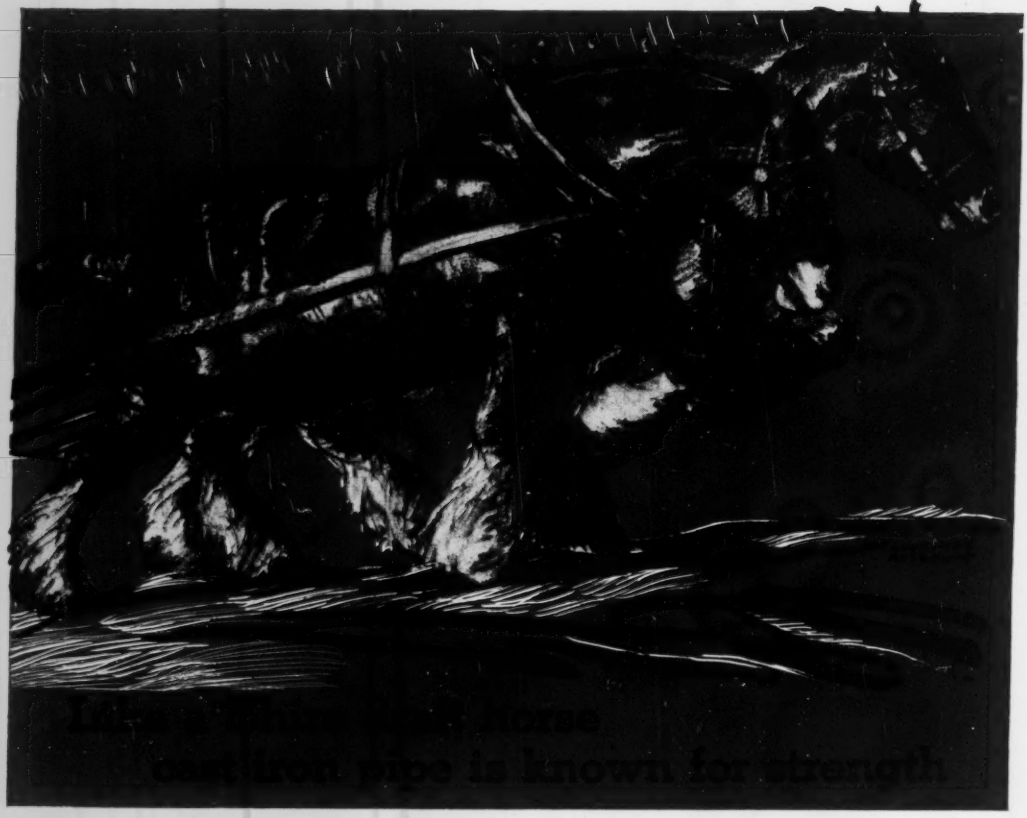


Oil Transfer Pumps

Cooling Water Circulating Pumps

Evaporative Type Engine Water Coolers

The STRENGTHS you need



The strengths demanded of pipe to be laid under expensive modern pavements, if costly repairs and replacements are to be avoided, are known strengths—proved by experience and determinable by tests. The four strength factors that pipe must have to withstand beam stresses, external loads, traffic shocks and abnormal working pressures are listed on the opposite page. *No pipe, deficient in any of these strength factors, should ever be laid in paved streets of cities, towns or villages!* Cast iron water and gas mains, laid over a century ago, are serving today in the streets of 30 or more cities. These service records prove that cast iron pipe not only resists corrosion but has all the vital strength factors of long life and economy.

CAST IRON PIPE

in pipe for city streets . . .

No pipe that is deficient in any of the following strength factors should ever be laid under paved streets.

CRUSHING STRENGTH

The ability of cast iron pipe to withstand external loads imposed by heavy fill and unusual traffic loads is proved by the Ring Compression Test. Standard 6-inch cast iron pipe withstands a crushing weight of more than 14,000 lbs. per foot.

BEAM STRENGTH

When cast iron pipe is subjected to beam stress caused by soil settlement, or disturbance of soil by other utilities, or resting on an obstruction, tests prove that standard 6-inch cast iron pipe in 10-foot span sustains a load of 15,000 lbs.

SHOCK STRENGTH

The toughness of cast iron pipe which enables it to withstand impact and traffic shocks, as well as the hazards in handling, is demonstrated by the Impact Test. While under hydrostatic pressure and the heavy blows from a 50 pound hammer, standard 6-inch cast iron pipe does not crack until the hammer is dropped 6 times *on the same spot* from progressively increased heights of 6 inches.

BURSTING STRENGTH

In full length bursting tests standard 6-inch cast iron pipe withstands more than 2500 lbs. per square inch internal hydrostatic pressure, which proves ample ability to resist water-hammer or unusual working pressures.

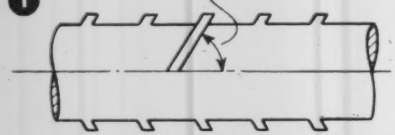
CAST IRON PIPE RESEARCH ASSOCIATION, THOS. F. WOLFE, MANAGING DIRECTOR, 122 SO. MICHIGAN AVE., CHICAGO 3.

SERVES FOR CENTURIES

Reinforcing Bars
HAVE TO BE GOOD...
to meet ASTM A305

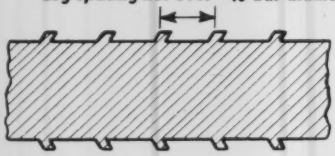
ASTM SPECIFICATION A305-50T REQUIRES

1. *Must be 45° or over*

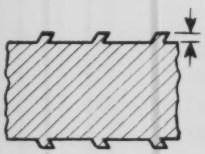


From 45° to 70°, the lugs must reverse in direction on each side or on opposite sides

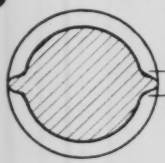
2. *Lug spacing not over 7/10 bar diameter*



3. Lug height must be at least 4 to 5% of nominal bar diameter



4. Gap or longitudinal rib width must not exceed 12½% of nominal perimeter of bar

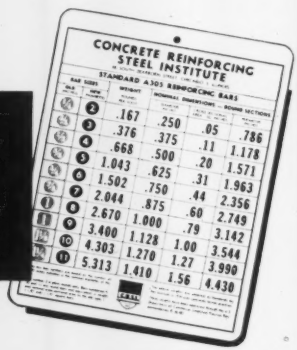


When you specify reinforcing bars that meet ASTM A305-50T, you *know* these bars will have high bonding strength. For Specification A305 sets up rigid standards as to the direction, height, and spacing of lugs on the bar. Improved bars that can meet these specifications provide high bonding strength that reduces the size of tension cracks and often eliminates the need for hook anchorage.

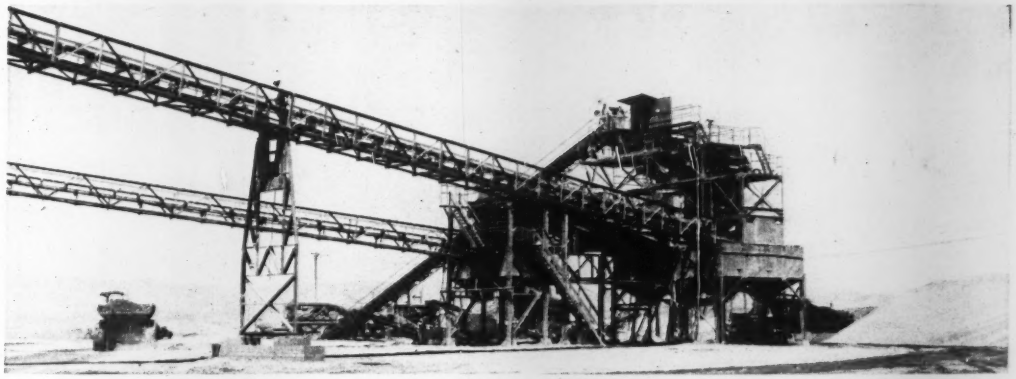
The new ACI Building Code, just ratified, permits greatly increased bonding stresses and the elimination of hook anchorage when A305 bars are used. To you, this means lower steel costs and lower placement costs—as well as sounder, more permanent structures.

Your reinforcing bar fabricator is now offering bars that meet these standards. When specifying A305 bars, indicate size with the new number designations. A new bar chart, covering these designations, will be sent on request.

Write for FREE NEW BAR CARD



CONCRETE REINFORCING STEEL INSTITUTE • 38 S. Dearborn St., Chicago 3



(A) Gravel is processed, and dirt and silt are screened and removed from sand in this washing and classifying plant. From here, the sand and gravel are carried by conveyors to storage piles. Extensive use is made of electric-powered conveyors to provide economical and reliable transportation. G-E motors and control are used throughout the portable arrangement.

ON JOB AFTER JOB

portable plant makes aggregate

... Electrically

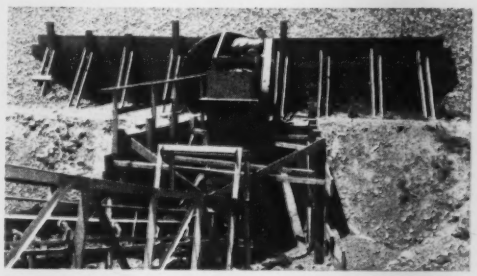
G-E Equipment Powers 245-Tons-per-hour Plant to Process Aggregate Wherever It Is Needed.

This portable aggregate and batch plant has now been operated by the Western Contracting Corp. on four projects. Shown here set up near Newman, Calif., to supply aggregate for the Delta-Mendota irrigation canal, the plant has recently been moved to Yuma, Ariz., to do a similar job for the Welton-Mohawk canal. In 1946 the plant was moved 20 miles to the Newman site, set up, and put in operation in 10 days.

General Electric co-ordinated motors and control are used throughout. They give plant operators accurate control of the process, and have cut outages to a minimum. Motors range from 7½-hp G-E Pacific gear-motors driving conveyor belts to a 150-hp rock crusher motor. A 75-hp vertical motor drives a deepwell pump to supply the plant with water.

Electrified construction equipment can pay off for you, too. With co-ordinated use of G-E motors and control and G-E power distribution systems you will get safer, more flexible, and more efficient operation. *General Electric Company, Schenectady 5, N. Y.*

(B) Oversize rocks are removed by this scalping screen at the beginning of the conveyor system. A G-E 20-hp motor operates the screen. Maximum flow of material to the screen comes from an apron feeder operated by a G-E variable speed motor remotely controlled with a rheostat by the operator at the top of the washing plant.



(C) Gravel is drawn from the storage pile by a conveyor powered by a 10-hp G-E Pacific adjustable-speed gear-motor. This drive permits low adjustable speeds, easily changed by a pilot motor which is controlled from the top of the washing plant.

Ask him Today!

Whether you buy or build construction equipment, your G-E representative can show you how to do a better job—at lower cost—by complete electrification. Write him now, and he'll call on you at your convenience.

ELECTRIFIED EQUIPMENT
Speeds Construction—
Cuts Costs

GENERAL ELECTRIC

664-17

ANY TYPE OF VALVE

any place, any time, by any power-source available

CAN BE OPERATED BY *Limitorque*

- ✓ INSTANTLY
- ✓ ACCURATELY
- ✓ SAFELY
- ✓ DEPENDABLY

LimiTorque opens and closes valves of all makes and types up to 96" diameter by the "push of a button" from either remote or nearby control panels. Damage to stem, seat, disc, gate or plug is prevented because the Torque Seating Switch *limits the torque*, shuts off the motor if an obstruction occurs.

Greater safety is afforded workmen by LimiTorque Remote Control as it is unnecessary to go to high, low or dangerous locations for manual operation.

LimiTorque may be actuated by any available power source . . . electricity, steam, water, gas, oil or air.

LimiTorque Controls are obtainable through valve manufacturers. Thousands in daily use on land and sea . . . in Power Plants, Central Stations, Water Works, Refineries, and Oil Pipe Lines.

LimiTorque can always be declutched for handweeel operation regardless of weather or. electrical conditions.

For full details . . . write for Catalog L-50 — please use your Business Letterhead.

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Industrial Gears and Speed Reducers
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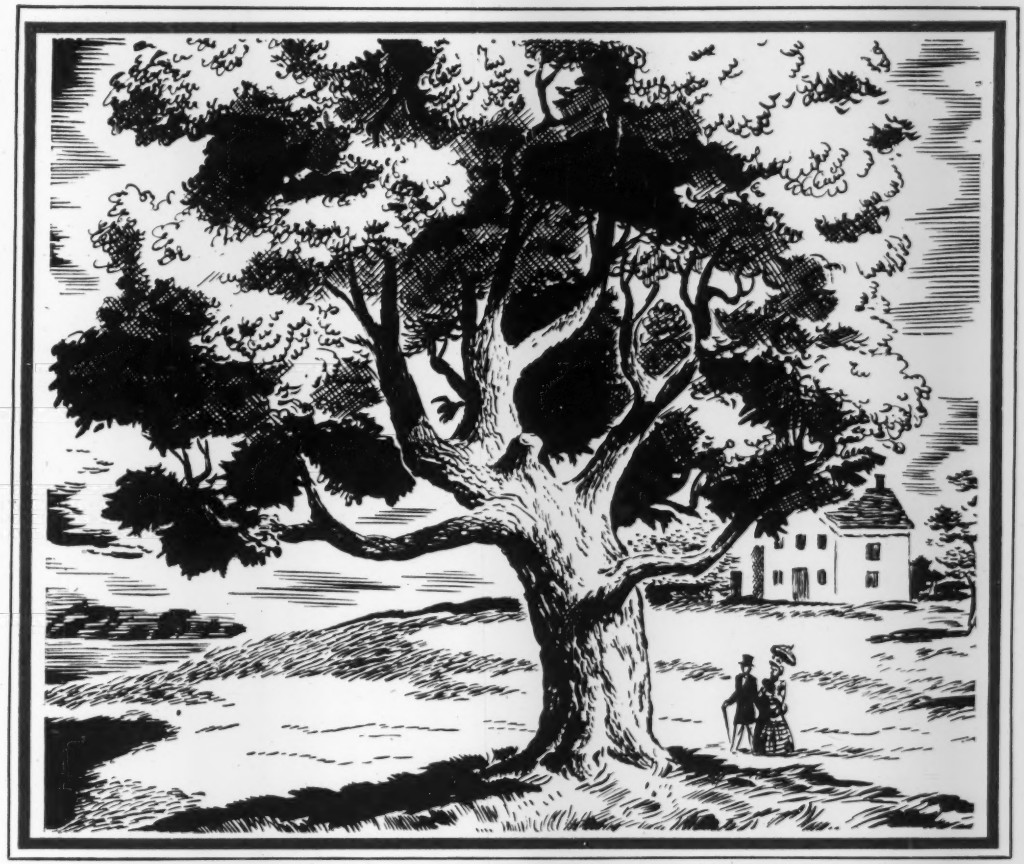


Hartford's famous Charter Oak which flourished for 200 years before it fell in 1856

Hartford, Connecticut, has a cast iron gas main in service that was installed more than a century ago. On the anniversary of its 100th service year a section of this main was uncovered for inspection and found to be in excellent condition. This main, installed in the days of horse-drawn vans and vehicles, is now serving under the pavement of one of Hartford's principal thoroughfares and withstanding the traffic shock imposed by modern buses and multi-ton trucks. Despite such unforeseen stresses, cast iron water and gas mains, installed over a century ago, are still serving in the streets of more than 30 cities in the United States and Canada.

United States Pipe and Foundry Co.,
General Offices, Burlington, N. J.
Plants and Sales Offices Throughout the U. S. A.

U.S. PIPE

NUMBER SEVEN OF A SERIES

The Surveyor's Notebook

Reporting on Unusual Surveying Problems and Their Solutions

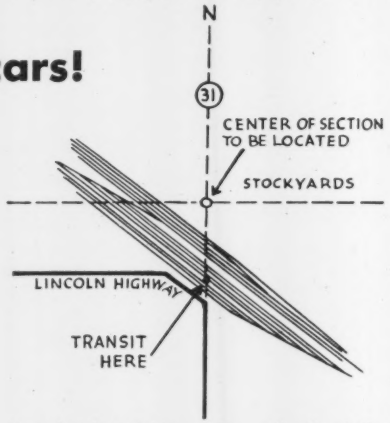
Notekeeper: W. & L. E. Gurley, America's Oldest Engineering Instrument Maker

Boxed in by Boxcars!

"Having spent half a century behind the transit, or directing its use, I've solved every type of field problem," recalls the Deputy Surveyor of Douglas County, Nebraska. "But while locating alignment for the Lincoln Highway through the town of Valley, Nebraska, I hit a situation that almost had me stumped."

"My objective was to set a point at the intersection of the center line of Section 31 and the center line of a northwesterly street, immediately adjacent to the Union Pacific's main-line right of way. This depended on the true location of the quarter-section line, which was completely blocked by boxcars, gondolas, flats and whatnot packed solid on 10 yard tracks of the right of way. On top of that, stockyards straddled the quarter line.

"Looking north along the center of the highway, I noted an extra-high boxcar, about on line, on an inner track. I climbed to the top, and found the answer to my problem. The terrain was flat as a floor, so with a tall marker



(two bamboo fishing poles, spliced) at the north corner, and a picket at the south, it was a cinch to see through the mile.

"Checking with the stationmaster to make sure there would be no switching, I borrowed a rope; hoisted my Gurley Transit to the top; and soon balanced in on line. Two trains passed and shook the instrument; but that was soon corrected. I double centered to be sure that the shift of my body had no effect.

"Reference points for checking center of the section—if found—and the intersection point of the right of way were set. The Gurley had done its job, for a few minutes with a spade revealed a three-inch pipe—the corner to which we had no ties."

SURVEYORS: Send in an unusual field experience for this series. We also welcome your comments and suggestions.

Gurley for City and County Surveying

"That day we added a boxcar to our list of useful surveying tools—a list always headed by a Gurley Transit."

Surveying both city and county jobs from his Omaha office, this surveyor requires a versatile instrument. He has just added another Gurley Transit; keeps one in his car at all times for incidental work.

Whatever type of surveying *you* do, you'll find there's a Gurley Transit especially designed for the job. Bulletin 50 gives all details.

W. & L. E. GURLEY, 518 FULTON STREET, TROY, N. Y.

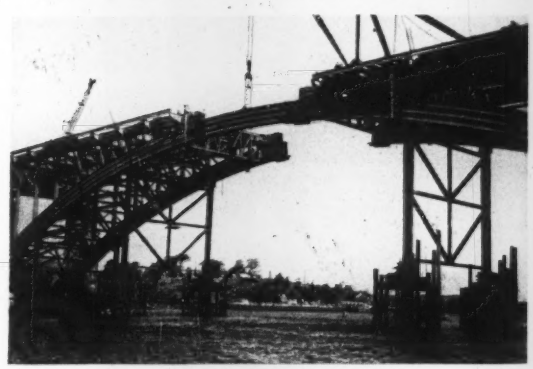
Surveying and Engineering Instruments, Hydraulic Engineering Instruments, Standard Precision Weights and Measures, Paper and Textile Testing Instruments, Reticle Making Facilities, Aeronautical Navigating Instruments, Meteorological Instruments.

GURLEY

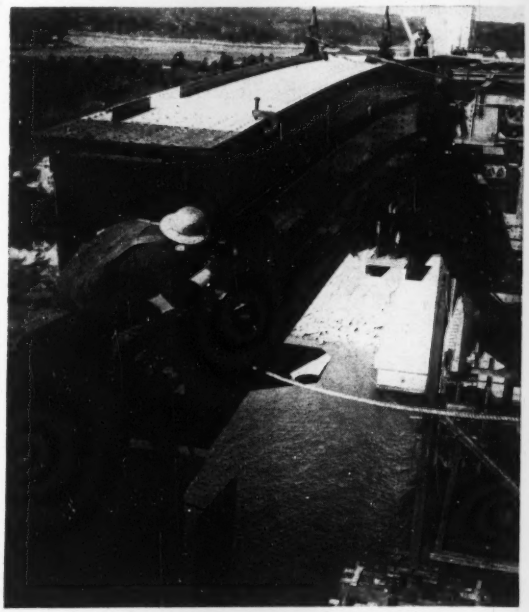
Surveying and Scientific Instrument Makers Since 1845

Showing the new Annisquam River Bridge at Gloucester, Mass. The box-girder arch structure carries Northern Circumferential Highway over the Annisquam River, and connects Cape Ann with mainland. Designer: Department of Public Works, Commonwealth of Massachusetts.

New Link in Massachusetts Highway System



Erection of arch nears completion as the first of the closing arch ribs is eased into position between the ends of adjacent sections which are erected on falsework.



Bridge work as steelworkers see it. This closeup shows placing of riveted arch rib.

This attractive steel arch, recently completed north of Gloucester, Mass., is known as the Annisquam River Bridge. It is part of the popular Northern Circumferential Highway, and offers something new to motorists in the Gloucester area — a high-level river crossing between picturesque Cape Ann and the mainland.

The Annisquam River Bridge is of the box-girder arch type. Its main arch span is 426-ft in length. At each end it has a 209-ft girder continuous over three spans. Its piers are faced on three sides with Chelmsford granite. The structure carries two 26-ft lanes, separated by a 4-ft center mall, and has two 5-ft walks for pedestrians.

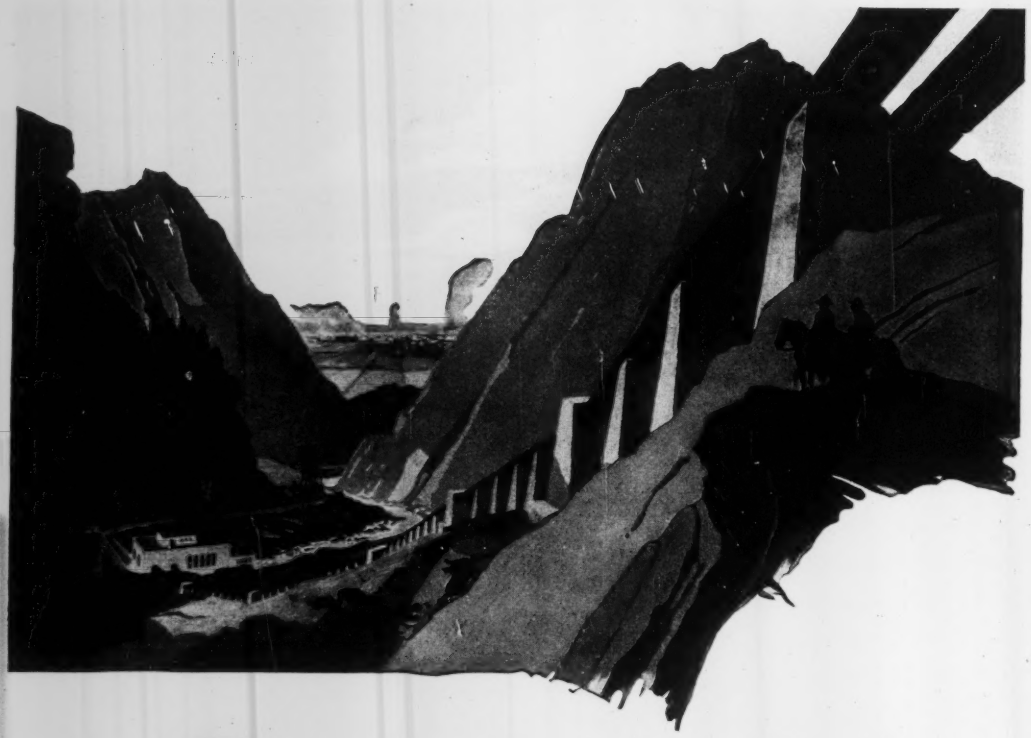
Bethlehem handled both the fabrication and erection of the 2512-ton superstructure of this important new link in the growing system of Massachusetts highways.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

FABRICATED STEEL CONSTRUCTION

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

★ BETHLEHEM STEEL ★



SMITH Impulse Turbines

FOR HIGH HEADS, and wherever the head and water quantities available prohibit the use of reaction-type machines. Ideal for installations in remote localities because of the ease with which the completed unit may be transported. The simplicity of design, facility of operation and greater dependability remove the necessity of skilled operators and attendants. Smith's solid-cast runner design provides the additional advantages of closer spacing of buckets resulting in increased speed and consequently, a decrease in the size of the turbine unit, as well as the generator. Write for your copy of our Bulletin — "Impulse Turbines by SMITH!"

Impulse runner of *solid-cast* design, an exclusive SMITH advantage.

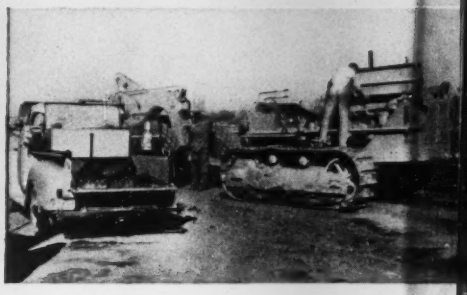
S. MORGAN SMITH COMPANY

YORK, PENNSYLVANIA

POWER by SMITH

Your strong right arm...

in time of need



BECAUSE of the vast defense mobilization program, material shortages and extra production demands have gripped the nation. They affect particularly the heavy industries and the distributors and users of their products. And huge as America's facilities have become in recent years, they still are not large enough to keep pace with both military and civilian needs.

Nevertheless, as an owner of "Caterpillar" products, you are among the more fortunate. Your "Cat" equipment has been built for long life and to withstand severe working conditions. What's more, it is backed by a dealer organization that is world-famous for experience, accessibility, mechanical facilities and field service to keep you going "come hell or high water."

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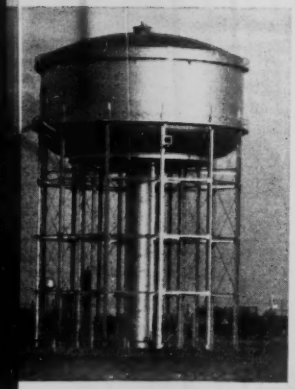

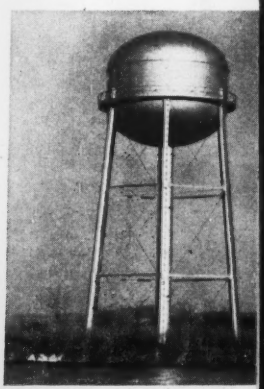

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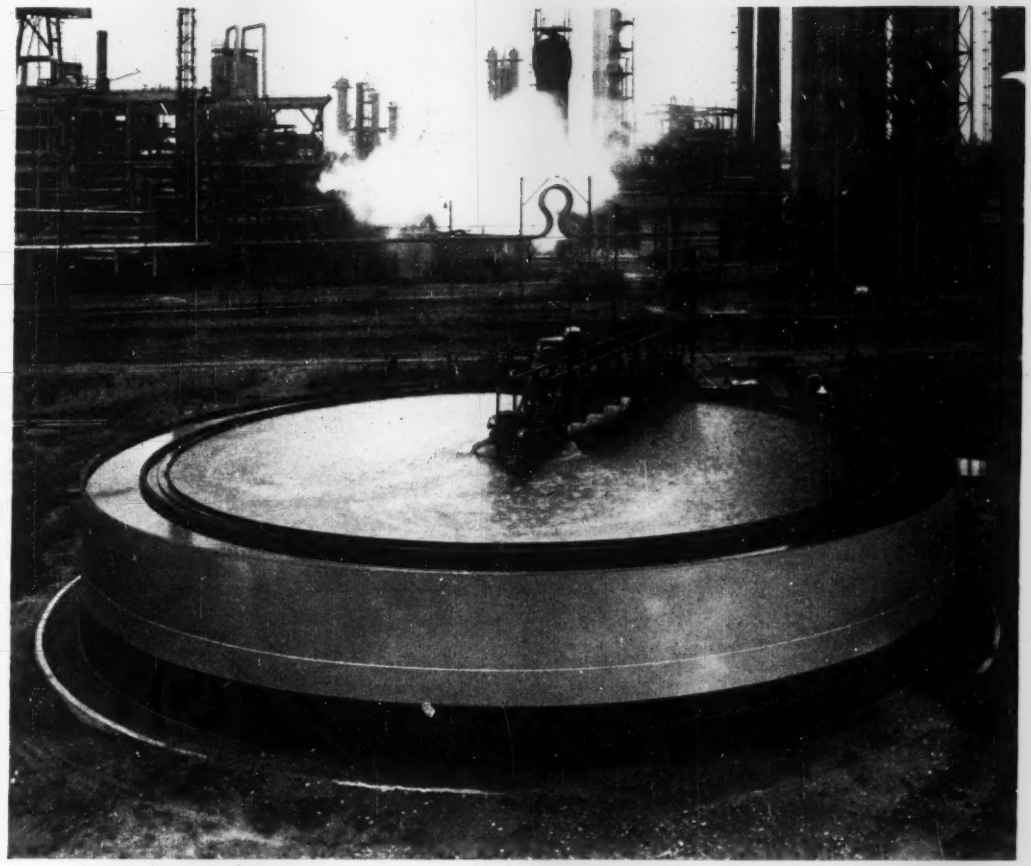

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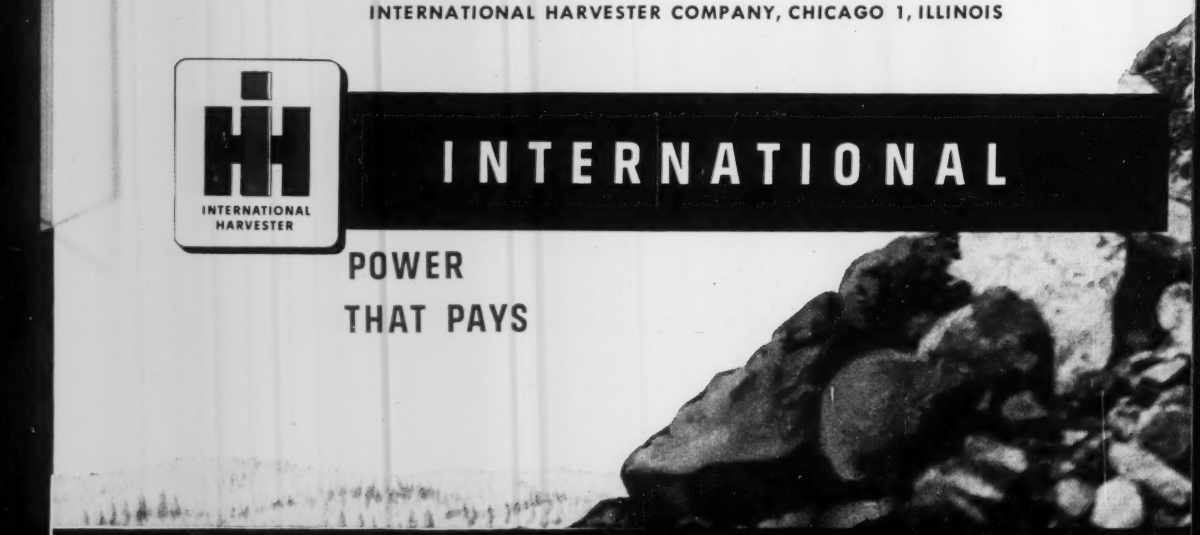

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JULY, 1951

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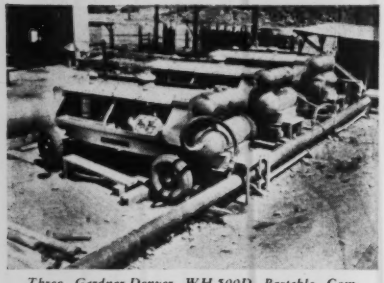

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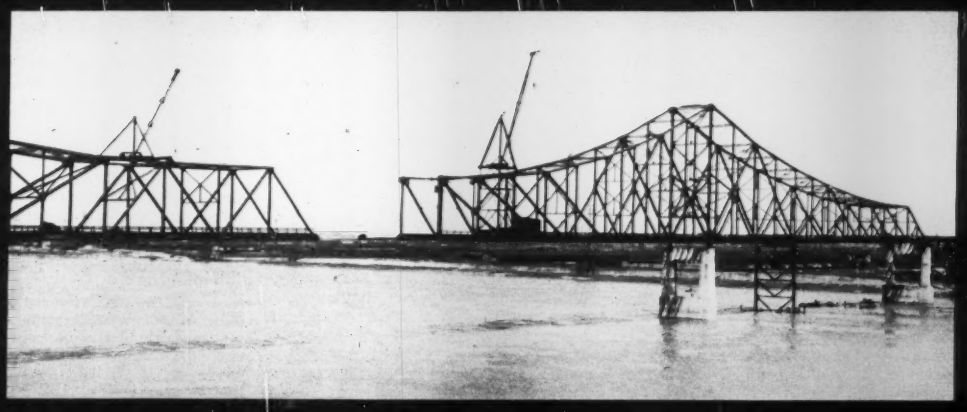


East St. Louis Bridge erected by cantilever method

E. L. DURKEE, M. ASCE, Engineer of Erection, Bethlehem Steel Co., Bethlehem, Pa.

CONVENTIONAL cantilever methods were employed for the erection of the East St. Louis Veterans Memorial Bridge, which spans the Mississippi between East St. Louis, Ill., and St. Louis, Mo. The general features of this bridge were described by Craig P. Hazelet, M. ASCE, in CIVIL ENGINEERING for March 1950. Anchor arms were first erected on falsework, followed by cantilever erection of the main span without any temporary supports. Each half of the suspended span was cantilevered from the end of the cantilever arm, and the two halves were joined by means of jacking devices in both the top and bottom chords at the ends of the cantilever arms. Cantilever erection is generally considered simpler and cheaper than floating in the suspended span where the members are strong enough to permit it—or even when some reinforcing of the truss members is required.

The order of construction and completion of the piers was first Nos. 8 and 9 on the west side, then Nos. 11 and 10 on the east side (Fig. 1). The schedule was such that the west half could be started and erected to the center of the suspended span before the piers for the east half were ready for steelwork. By this method, only one erection traveler and one set of equipment for unloading and transferring the steel were required. After completing the west-side steelwork, the traveler was removed and reerected on the east side. Thus the west half of the structure, cantilevered out to the center of the main channel, stood waiting about six months while the east half was being erected and cantilevered out to join it. This schedule required a minimum amount of equipment and a minimum erection crew although the total erection time was increased.

Tower Traveler Erects Steel

Many types of equipment have been considered and used for the erection of through-truss cantilever bridges, and each has its advantages and disadvantages. A derrick traveler operating from the deck of a through span requires an excessively long boom to reach the peak of the truss over the main piers—in this case the boom length had to be at least 160 ft, much longer than practical. The alternative method sometimes used of running a creeper traveler over the top chord has some serious disadvantages: Top-chord members are seldom heavy enough in bending to support the moving traveler load; the traveler must be designed to adjust itself to the varying slope of the chord in every position; when the traveler reaches the peak of the truss it is a difficult job to get it by the sharp break in the chord at this point; and erection and removal of the traveler at this height is somewhat more difficult.

For this bridge a tower traveler was used. It consisted of an ordinary stiffleg derrick with 100-ft boom mounted on a 66-ft tower, of triangular shape in plain view to fit the 60-deg angle between the stiff-legs. The triangular shape makes it possible to bring loads close up to the traveler from the rear. The disadvantage of the tower traveler is its greater weight, and the fact that the tower itself extends above

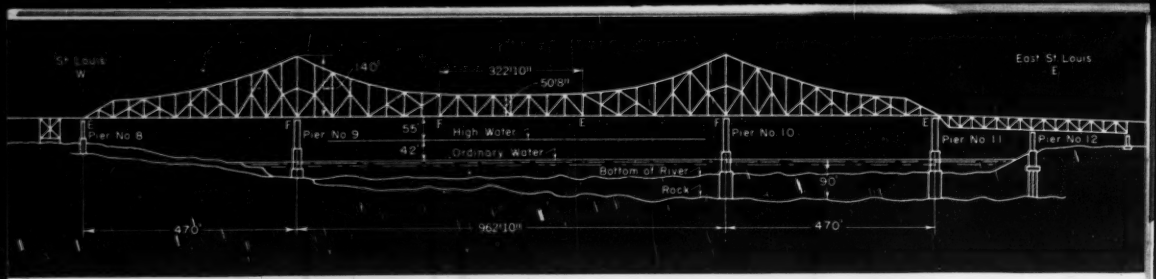
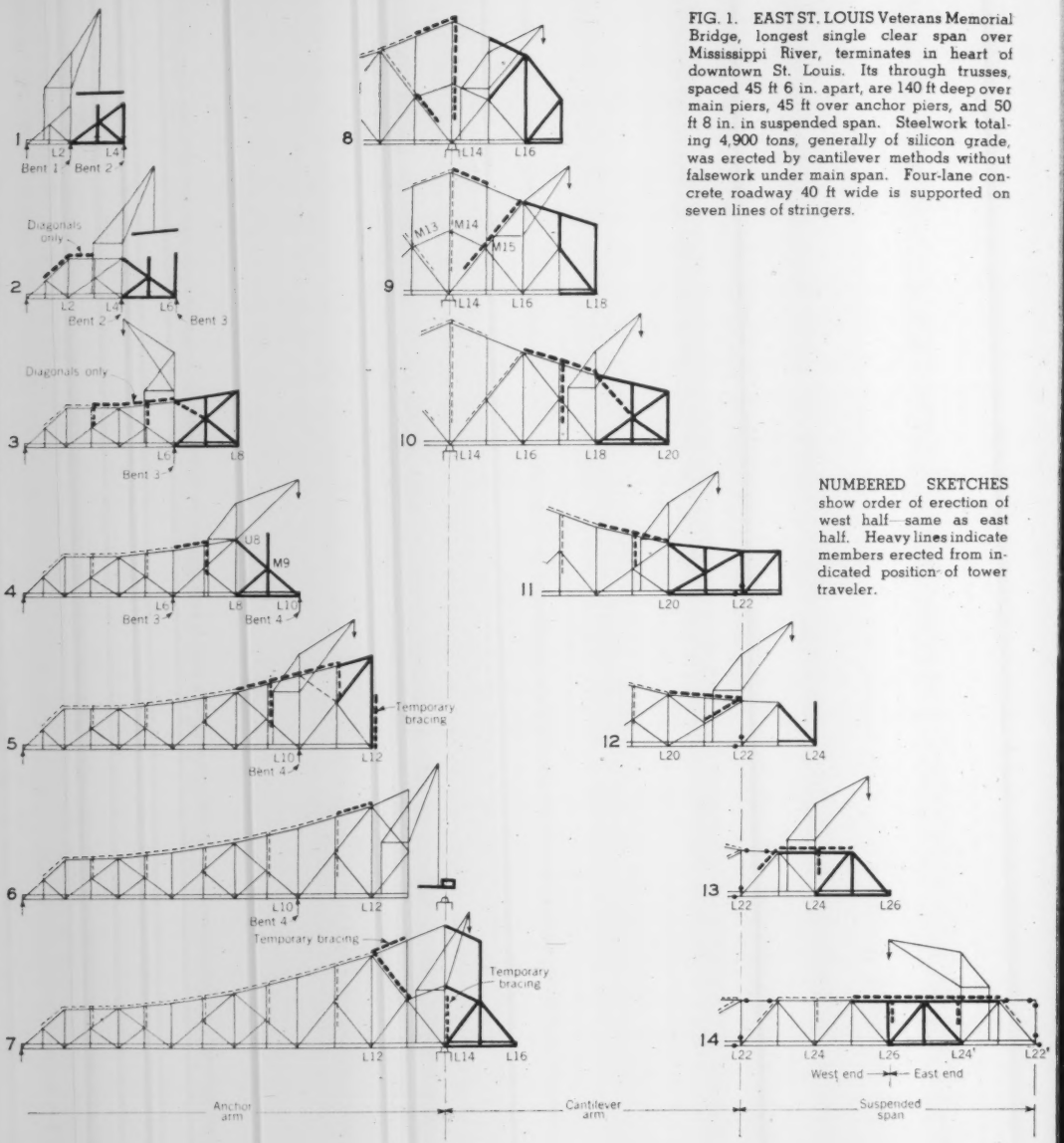


FIG. 1. EAST ST. LOUIS Veterans Memorial Bridge, longest single clear span over Mississippi River, terminates in heart of downtown St. Louis. Its through trusses, spaced 45 ft 6 in. apart, are 140 ft deep over main piers, 45 ft over anchor piers, and 50 ft 8 in. in suspended span. Steelwork totaling 4,900 tons, generally of silicon grade, was erected by cantilever methods without falsework under main span. Four-lane concrete roadway 40 ft wide is supported on seven lines of stringers.



NUMBERED SKETCHES show order of erection of west half—same as east half. Heavy lines indicate members erected from indicated position of tower traveler.

the top chord for about half the length of the bridge, thus preventing erection of the top-chord bracing until the tower has passed a panel point.

On each side of the river this traveler was erected on the deck approach span adjacent to the end of the anchor span. On the St. Louis side, a crawler crane working on the ground was able to set up a 35-ton stiffleg derrick with a 100-ft boom on the deck of this approach span, and this derrick in turn erected the tower traveler. The stiffleg boom then was shortened to 80 ft for handling the steel.

On the East St. Louis side, the problem was more complicated. Here there were two deck-truss spans each about 215 ft long, the first spanning the river bank and the second spanning some railroad tracks and the waterfront street. Over this second span, the only one that could be reached from ground level, there was a 135,000-volt transmission line with wires only 38 ft above the bridge deck. Obviously the tower traveler had to be erected on the river side of these wires, where the deck was too high to reach from the ground or from the water. Here again the auxiliary stiffleg derrick was used. This time it was erected on the second span, using a crawler crane working in the street and from the ground. The position of this derrick and the length of its boom were such that in all positions it had proper clearance from the high-tension wires.

This auxiliary derrick then picked up the crawler crane from the ground in three sections—boom, cab, and undercarriage—and erected it on the deck. It moved forward over a specially constructed timber roadway on to the first deck span and there erected the tower traveler adjacent to the anchor pier. The crawler crane then returned to the material derrick, which lowered it back to the ground.

TOWER TRAVELER at Pier 11 (Fig. 1) erects first falsework bent for east 470-ft anchor span (February 7, 1950).

Steel Shipped by Rail

The method of shipping and handling the 4,900 tons of steel from the Chicago fabricating shop was determined only after careful consideration of the method of erection. The heaviest members to be handled weighed 23 tons, and the longest was about 100 ft. These weights and lengths are not considered excessive, particularly for a structure of this size. They were determined largely by the capacity and reach of the erection traveler. All-water shipment from Chicago was possible but would have required transferring some steel from barges to rail or docks for that part of the structure over the ground on both sides of the river. Such facilities as existed in the St. Louis area were not suitable for this arrangement so water shipment was abandoned in favor of all-rail movement. A considerable tonnage of steel could be stored on the St. Louis side. However, practically no yard facilities were available on the east side of the river, so rail shipments for that end of the bridge were scheduled to arrive in exact accordance with construction needs.

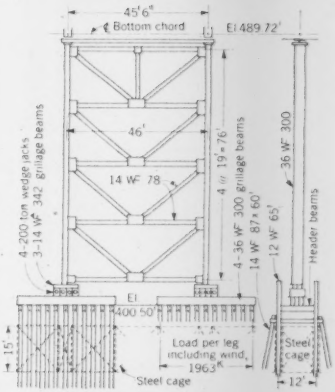


FIG. 3. Four falsework bents (above), resting on 200-ton wedge jacks on steel grillages, supported successive steps in erection of anchor arms. Under east arm, 12-in. steel piles were driven in 25 ft of water to 20 to 30-ft penetration for bent foundations. Under west arm, heavy timber mats on dry ground sufficed for three bents; fourth rested on timber piles driven to rock. Maximum load on any one falsework column was 980 tons, including 229 tons from wind.

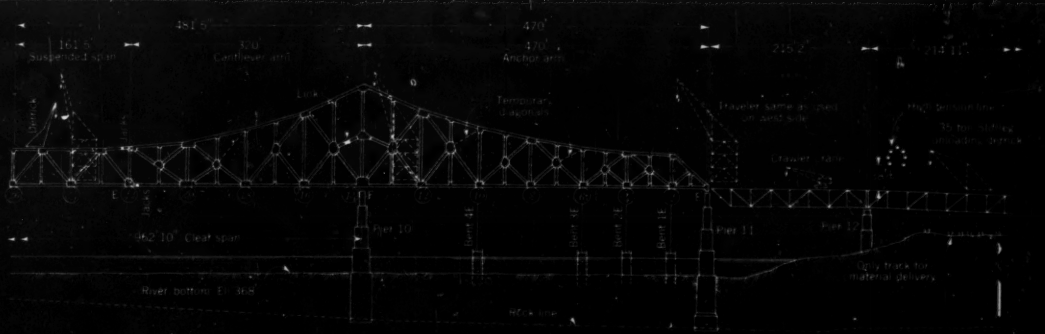
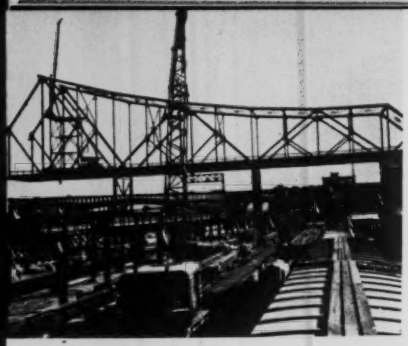


FIG. 2. ERECTION METHOD is illustrated by east half—counterpart of west half, which was erected first. For each half, steel was erected from end to middle of suspended span by nearly identical procedures. Four temporary bents supported 470-ft anchor spans, but each cantilever arm and half of suspended span—481 ft—were erected without support, close to a record length. Erection stresses required temporary diagonal tension members, shown dotted.



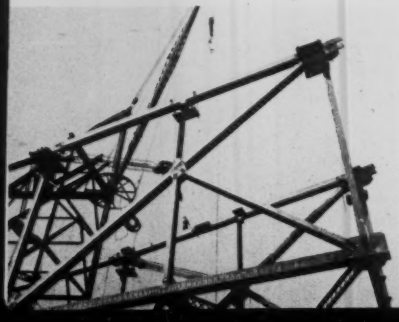
FORTY-TON CRAWLER CRANE serviced material yard during erection of west anchor span. Beyond, tower crane is erecting steel at L12. Elevated tracks of The Terminal Railroad Association appear at left of crane, and Eads Bridge is seen in background.

On the west side, steel was trucked to within direct reach of the tower erection traveler or was picked up from trucks by the material derrick on the approach span and placed on small material trucks on the bridge deck. These trucks ran on a standard-gage railroad track laid on ties on top of the two outside floor stringers, adjacent to one truss. A small, gasoline-powered locomotive was used to push these trucks out to within reach of the tower traveler.

The same system was used on the east side, where all material was run out over the deck in this fashion, after being transferred directly from railroad cars to the bridge deck by the material derrick.

The operation of both the traveler, the material trucks and the gasoline locomotive on the permanent bridge-floor stringers, resulted in critically high bending stresses because of the relatively long spans and the resulting lateral instability due to buckling. These stringers have no steel bracing, the top flange being stayed by the concrete deck itself in the finished structure. A temporary bracing system and cross frames were employed at the midpoint in each panel so as to tie all the stringers together temporarily where the traveler stood and moved. The bracing between the two floor stringers carrying the material track was left in place until erection was completed on each half of the span.

ERECTION STRESSES required temporary tension members in trusses and bracing. Here tower traveler has reached L6, position 3 in Fig. 1, and wire-rope falls with turnbuckle adjustment form temporary diagonals for U6-M7.



Anchor Spans Erected on Falsework

Each anchor arm was erected by supporting it on temporary falsework bents located at panel points L2, L4, L6 and L10, as shown in Fig. 2. The main pier is at panel point 14. On the St. Louis side, the anchor span is entirely over the ground except that the main pier, No. 9, is at the water's edge, at the foot of the paved levee at this point. As the ground was generally dry and firm, three falsework bents (Fig. 3) rested on heavy timber mats 32 × 8 ft in plan, laid directly on the ground after it had been leveled off. For the fourth bent, located on the stone-block paved levee, it was decided to remove the paving to protect it from damage and make a level base. Under the pavement the ground was soft and wet. A brick storm sewer passed under one leg, and some old concrete building footings were also uncovered. Because of this condition, and because a possible rise in the river would flood this footing, timber piles were driven and capped with 12 × 12-in. timbers to support this bent. A small amount of settlement under the L6 bent was corrected by jacks provided under the bent for this purpose, and for adjusting the elevation of the steelwork.

On the east side of the river, where the anchor span is entirely over the river, the water is about 25 ft deep at ordinary low stages. The bottom is of good river sand, considered quite suitable for driving and supporting piling although subject to some scour in time of flood. The erection schedule contemplated completion of the anchor arm on these bents before high water. Steel-pile footings were used for each of the four bents, driven through a steel-cage template 15 ft deep (Fig. 3), which acted both as an accurate spacer and as bracing for the piles, which were 12WF65 sections. The maximum pile load was 24 tons without wind, and 32 tons including overturning moment from wind. Steel header beams 12 ft long, framed between each pair of piles, supported steel grillage beams, which in turn supported the column bases of the upper falsework bents.

Three bents were made up; the first, at L2, was removed and reused at L10. The same three bents were used on each side of the river, adjusted in length to suit the difference in height. The bents were erected in two or three column lengths, and the bracing assembled between them, piece by piece. The lower sections were guyed until the upper section was erected and the bottom chord of the bridge landed on it to make it stable.

As erection advanced (Fig. 1) and each succeeding falsework bent was erected, the previous bent was lowered to release its load. Each bent, together with the anchor pier, was designed to carry the entire erection load at each stage. When the main pier was reached, at panel point L14, the span was only partially landed on the fixed shoe there, leaving part of the load on the bent at L10. Cantilever erection progressed to L20, six panels beyond the pier, before the L10 bent was entirely released. This arrangement was necessary because the anchor arm was not considered entirely self-supporting without this much of the cantilever arm in place to relieve the simple-span stresses in it.

Erection of the anchor arms provided no unusual problems. Because of the expansion rocker links at the L0 end, where erection started, it was necessary to temporarily wedge the span both ways against the anchor pier to make the span stable longitudinally. When the steel reached the main pier at L14, the wedges were replaced by four 50-ton journal jacks, which rocked the span longitudinally to adjust its position to the existing conditions and permit landing on the fixed shoes. The L10 falsework bent was then lowered sufficiently to give a small positive load on the shoes, and the L0 links were freed to permit normal expansion movements at the anchorage pier.

Temporary bracing was required in some traveler positions to provide proper stability, and all erection positions (Fig. 1) were carefully investigated for erection stresses in the trusses and for necessary bracing. From panels 6 to 10 and from 10 to 14, semi-cantilevering of the steel in the four panels required the use of two temporary diagonal truss members, because of the Warren type of trussing. These temporary members were U6 to M7 and from U10 to M11, and were made up of wire-rope falls with turnbuckles for adjustment. A similar temporary diagonal was also required in the cantilever span from U18 to M19 and from U22 to U23, at the end of the suspended span.

Once the main piers were reached, erection was continued to the center of the main span from panels 14 to 26, or a distance of 481 ft, without support. While this is not a record, it is close to the longest free cantilever ever erected in this manner. It is one of the most spectacular erection methods, and at the same time it is safe.

Unusual Feature of Cantilever Arm

The cantilever arm itself presented only one unusual feature, which is common to most cantilevers of this type. The truss system over the main piers involves two sub-struts, M13-M14 and M14-M15, both of which are required and carry stress during erection. With the truss complete to panel 16, these struts carry no calculated stress and serve only to brace the 140-ft-long main vertical. If both were left rigidly connected they would form an indeterminate truss over the pier, with resulting high secondary stresses.

Various ways of relieving this stress and of effecting final closure of the main truss members in these panels have been used. A novel method was used on this bridge. The lengths of the two sub-struts were so detailed as to permit closure of all truss members as erected, with these struts carrying the entire erection stress. To relieve this stress, and transfer it into the main truss members, *one* of the struts was designed with a pair of temporary connection links built inside the member. At the proper time these links were partially burned through, raising the unit stress in the remaining section close to the yield point. This section was then heated red hot, or until the steel stretched the necessary amount to relieve the stress entirely. It was then burned in two and the links removed. A permanent slip joint at this point supports the strut, which was left in place for appearance. The *other* strut, which braces the main vertical, is rigidly connected at both ends.

Suspended Span Erected and Closed

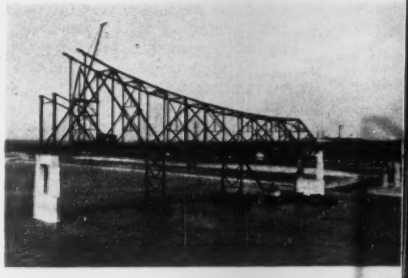
At the end of the cantilever arm, the top and bottom chords which frame between it and the suspended span carry no stress in the completed span and are known as dummy chords. During erection they must carry the full cantilever erection stress, for which they must be designed and connected, with provision made for freeing them after the suspended span has been joined at the center. They are designed as adjustable-length members, by means of built-in hydraulic jacks, and are used to control both the length and the angle of the two halves of the suspended span in order to effect closure. After closure the jacks are removed and the dummy chords are repaired and left in place for appearance.

At one end, the suspended span is fixed on the supporting pin in the bottom chord to prevent longitudinal movement. At the other end of this span there is a conventional finger-type expansion grating in the floor system to permit movement due to temperature changes between the main piers.

For this structure, provision for jacking to closure was provided in both dummy top chords but in only one of the bottom chords. At the other end of the suspended span there was the usual pin-connected detail permitting rotation but no longitudinal movement. As these members were erected, the bearing shims were adjusted so as to leave the half-span high at the center. The top chords were pulled back so as to provide an opening of 3 or 4 in. for erecting the closing top chord. The adjustable bottom chord at the one end was pushed forward so as to provide an overlap of the bottom chords at the closing panel point. This overlap was taken care of by a short removable section of the chord at this point, about 4 in. long. Both halves were thus rotated upward so that they were above normal height at the center.

The closing top chord was supported on temporary erection seats at one end. One end could then be connected. The diagonal truss members in the closing panel were connected at one end, and the other end was left free. The two truss gussets at the closing panel point were separated so that one arrived riveted to the chord on half of the truss, and the other with the adjacent chord on the other half of the truss. The floor stringers and bracing members in the center panels were omitted

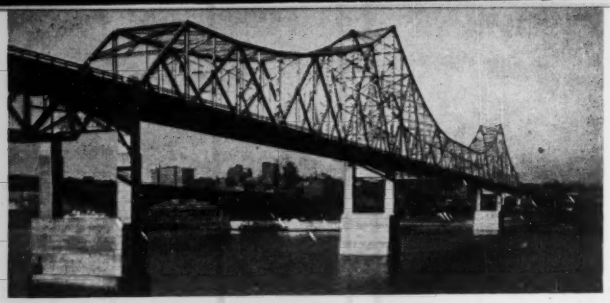
EAST ANCHOR SPAN reaches third falsework bent, as floating concrete plant tops out main pier (March 13, 1950).



EAST ANCHOR SPAN is seated on main pier (March 27, 1950) while floating crane dismantles falsework bents.

FROM MAIN PIER on east side, steel was erected as cantilever for length of 481 ft to mid span (April 21, 1950).

SUSPENDED SPAN was finished and closure completed on May 17, 1950. Clear unsupported length is 963 ft.



EAST ST. LOUIS Veterans Memorial Bridge was completed December 18, 1950, but work on approaches delayed opening to traffic until January 13, 1951.

until connection had been made and the span swung.

The first operation in connecting the suspended span, after all the truss members were in place, was to pick the load up on the jacks and remove enough shims to permit movement as required. By slacking off on the jacks, the length of the span could be increased so that the bottom chord joint matched and could be fitted up with pins and bolts. At this time the closing top-chord joint still stood open a small amount. Further slacking off of the jacks brought the top chord to bearing and the diagonals to a match, so that both could be fitted up with enough pins and bolts to carry the erection stress. The jacks and shims then were entirely released to free the suspended span from its temporary cantilever supports and "swing" it as a simple suspended span, as it was designed. The floor and bracing members in the closing panel were then erected.

This closure procedure was carried through successfully, the entire operation being accomplished in one day so as to avoid a continuous structure with indeterminate stresses.

As soon as the west half of the structure was cantilevered to the center, the erection traveler was removed for use on the east side. To do this, a small stiffleg derrick was erected on the top chord, immediately behind the traveler. The derrick had a 70-ft boom powered by a small gasoline engine located on the bridge deck. This derrick removed the tower traveler complete, lowering the members to the deck, where they were run back over the material track to the derrick at the anchor pier, unloaded and transferred by truck and rail to the other side of the river.

The auxiliary derrick was left standing on the top chord on the west side. After the east half of the structure was erected and the suspended span swung, this derrick was moved out to the center of the span, where it removed the tower traveler in the same manner as before. Finally, the derrick itself was removed by using its own boom as a gin pole.

Fitting Up and Riveting

Sufficient fitting up to carry erection stresses was done as erection proceeded, pins being relied on to properly align the members and to carry most of the erection stress. Milled joints of truss members were fitted up with a minimum of pins to permit the joint to come into full bearing. These joints were not riveted until there was actually compressive stress in the member, except where this condition could not be attained during erection. Such joints, which occurred at L2, L4 and U8, were brought into tight contact as soon as possible, pinned and riveted. Other truss joints were riveted as soon as convenient.

All the truss members were cambered by lengthening or shortening them as fabricated so they would have their proper length under a certain stress condition. For the bottom chords, this variation was between $\frac{7}{32}$ in. more than, and $\frac{3}{16}$ in. less than, the geometric panel lengths. The floor stringers were fabricated to geometric lengths and therefore would not fit as erected without bowing the floorbeams. The curb stringers were so close to the trusses that they had to be fitted up with $\frac{3}{4}$-in. bolts in $\frac{15}{16}$-in. holes to permit the necessary adjustment in length. Those stringers that carried the traveler load were fully fitted up for this load. At the expansion points $1\frac{1}{4}$-in. bolts were used in $1\frac{5}{16}$-in. holes to brace the floorbeam and carry the traveler load. They were replaced with the permanent $\frac{7}{8}$-in. bolts as soon as the next panel of stringers was erected. The curb stringers had to be disconnected and moved to permit riveting the chord splices opposite them.

The same difficulties with respect to panel lengths applied to the fabrication and erection of the lateral bracing, but here some adjustment was made in detailing so that this bracing could be erected with the chords, with the mismatching kept to a maximum of $\frac{3}{32}$ in. Heavy pinning was not permitted, and small bolts were used as required until the erection stresses brought the panels to a length which permitted pinning and riveting. Every effort was made to avoid slack or loose laterals in the finished structure. Some participation in chord stresses cannot be avoided.

Riveting of the sway frames and portal bracing in the anchor arms was delayed until erection reached the main piers and the span was practically free of falsework. Heavy pinning that would distort the holes, or reaming, was not permitted. In general, riveting was done at any time fair holes could be obtained without excessively heavy pinning.

Erection on the west side started June 10, 1949, and was completed November 8. Moving the equipment and setting up the traveler on the east side required until February 10, 1950, when erection actually started on that side. The suspended span was closed on May 17, 1950. Pouring of the concrete deck and alignment of the steel handrailing required another three months, so that the main river crossing was completed late in October 1950. On account of necessary work on the approaches, the bridge was not formally opened to traffic until January 13, 1951.

The bridge was designed by G. A. Maney and Associates, of Chicago, comprising the late G. A. Maney, the late Chas. A. Ellis, and L. T. Wyly, Members ASCE. Hazelet and Erdal, also of Chicago, were consulting engineers. The superstructure was awarded to Stupp Bros. of St. Louis, who in turn sublet the erection and fabrication of the main spans to Bethlehem Steel Co. N. J. Law, Jr., was Resident Engineer for Hazelet and Erdal during erection of the superstructure. Fabrication was by Bethlehem's Chicago Works and erection was in charge of H. E. Crider, Manager of Erection, Chicago Erection Department. Work in the field was in charge of Foreman J. E. Campbell, Resident Engineer R. C. Fiebrantz, and Field Engineer C. E. Weikel.

(This article was prepared from the paper presented by the author at the ASCE Louisville Convention in June 1951, before the joint session of the Construction and Structural Divisions presided over by Elmer K. Timby, M. ASCE.)

Higher accuracy in highway surveys brings long-run economy

J C CARPENTER, M. ASCE, Supervising Highway Transport Research Engineer, U.S. Bureau of Public Roads, Washington, D.C.

UNTIL 1948 there was no recognized standard for the accuracy of highway surveys. In that year, at the suggestion of Capt. H. W. Hemple, M. ASCE, Chairman of the Technical Division on Control Surveys of the American Congress on Surveying and Mapping, a proposed standard, formulated by the Committee on Highway Surveys, was adopted by the Congress as a preliminary draft to be widely distributed to highway engineers for discussion and comment.

In the subsequent three years, suggestions have been received from more than forty engineers actively engaged in highway surveys and representative of the entire country. The Standards Committee of the Division of Control Surveys has reviewed some of the technical details and recommended revisions.

A revised text has now been prepared, reviewed and accepted by engineers responsible for control surveys in the Coast and Geodetic Survey, the Geological Survey, and the Army Map Service. It will be recommended for final adoption at the annual meeting of the American Congress on Surveying and Mapping, June 18, 1951. The essential elements of the revised text are given in the paragraphs below.

THE ORDER OF ACCURACY prescribed for any highway survey is determined by the importance of the highway. Specifications of the Board of Surveys and Maps of the Federal Government for Horizontal and Vertical Control, May 9, 1933, are used as a guide.

FIRST-ORDER ACCURACY applies to major bridges, long tunnels, and all structures of such size and importance as to justify geodetic precision. For length alone, the error in closure shall not exceed one part in 25,000 and the probable error of main-scheme angles shall not exceed 1.5 sec. Levels shall be run with a precise prism level and invar-strip rods, in sections not more than a mile in length; each section shall be run forward and backward, and the two runnings shall not differ more than

$$0.017 \text{ ft} \sqrt{\text{miles in length of section}}$$

MODIFIED SECOND-ORDER ACCURACY is required for surveys of highways of sufficient importance to justify the expressway type of construction (four or more lanes). Length-measurement closure in position is limited to 0.01 ft multiplied by the number of 100-ft tape lengths, and the error in angular measurement shall not exceed

$$20 \text{ sec} \sqrt{\text{number of angles between tangents of traverse}}$$

Leveling shall be performed with a good engineers' level and target rod, be double run in sections not longer than a mile, and the two runnings shall be brought into agreement with a tolerance of

$$0.035 \text{ ft} \sqrt{\text{length of check section in miles}}$$

MODIFIED THIRD-ORDER ACCURACY is required for surveys of highways of sufficient importance to justify the construction of two or more lanes to serve traffic. Errors of closure for length measurements alone shall not exceed 0.02 ft multiplied by the number of 100-ft tape lengths, and for angular measurements shall not exceed

$$40 \text{ sec} \sqrt{\text{number of angles between tangents of traverse}}$$

Leveling closure is limited to

$$0.05 \text{ ft} \sqrt{\text{length of check section in miles}}$$

THESE ARE MINIMUM REQUIREMENTS, and more than usual care must be exercised to insure the desired results.

TESTS OF ACCURACY should be made between two or more points on the geodetic network of the Coast and Geodetic Survey where economically possible. State Standard Plane Coordinates should be used. Loop closures may be used. It is very important to have the tape standardized. Correction for altitude must be considered in checking with standard plane coordinates. Levels should be checked against Geodetic or Geological Survey bench marks. Check and recheck measurements should be made, adjusted, and recorded during reconnaissance, location, and construction. Survey monuments and bench marks must be permanent in character. Instruments and equipment must be maintained in good serviceable condition. Final accuracy should be defined and the results of each survey listed so that the data will be available for future surveys.

These standards have been promulgated to serve as definite criteria for the highway engineering profession. A few highway engineers objected to any change in their present procedure on the grounds that the standards appear to require accuracy beyond that needed for measurements of highway work and that highway funds should not be used in furthering the cause of mapping and allied activities. It is my personal opinion that as highway engineers continue to realize the advantages to be gained by using the standards, they will accept them as desirable and necessary.

In one instance where a special crew was used to establish Lambert control, reports showed that the survey cost was increased 5 percent. As controls are extended, the amount of this increase would be reduced, and would eventually result in a saving in survey costs. It seems certain that the small additional cost of meeting these standards will be more than offset by the permanent value of the final results. The benefits will inevitably accrue to the highway industry, and incidentally to all other related activities and to the public.

There are many advantages to be gained from adherence to the standards. Among these is the value of the reputation for accuracy, which has much weight in court cases and also may often be the means of avoiding controversy and litigation. In 25 states, plane coordinates have been legally recognized as control for land boundaries. Even in states which have not legally recognized the State Standard System of Plane Coordinates, these coordinates should be used, for they were established by the U. S. C. and G. S. and provide an official, recognized system, tied to the latitude and longitude of the land.

Highway surveys thus made will not become control networks to supplant geodetic surveys, but if made with reasonable care, conformable with economy, they will be usable supplements to geodetic networks.

(This article is an abstract of Mr. Carpenter's original paper presented before the Surveying and Mapping Division session, presided over by H. B. Aiken, at the Louisville Meeting.)

CHARLES E. DE LEUW, M. ASCE
President, De Leuw, Cather & Co., Chicago

UNUSUAL FEATURE of Louisville's city plan is integration between rail and vehicular traffic. In proposed design here shown, Louisville and Nashville main line runs in same open cut as vehicular expressway. Local traffic is carried over cut at five points.

Expressways and railroads integrated in Louisville's City Plan

ALMOST every American City of any size has prepared a long-range plan for urban highways of modern design. The schemes show great similarity, usually consisting of a number of radial routes focused on the central business district and interconnected by one or more belt highways. In this respect Louisville's plan is no different from any other.

In other respects, however, the Louisville plan is unusual. The city's expressway scheme is the result of a collision—a collision between plans for highways and plans for railroad grade-crossing elimination. A tentative system of expressways had been selected by local, state and city officials when De Leuw, Cather & Co. was employed to make a detailed study of grade crossings, physical plant, and terminal facilities of all railroads in the metropolitan area. The study was to include all passenger and freight main-line operations as well as those involving terminals, industrial services and transfers of merchandise from rail to truck. The firm's responsibility in connection with highways was to make a detailed study as to how they might be affected by railroad grade separations, terminal improvements and possible closing of streets.

As the planning work progressed, it became apparent to all concerned that: (1) to plan and build either the system of railroad grade separations or the system of expressways individually, without regard to the other type of transportation, would almost surely block chances of solving the companion problem for all time to come; (2) coordination in the planning of the two systems would result in substantially better facilities for both, with sizable over-all economies; and (3) many features of the previously considered expressways were incompatible with a feasible railroad improvement program.

Railroads Cannot Be Neglected

This situation is not peculiar to Louisville. In many cities the railroad problem is just as pressing as the need for urban expressways. Desirable objectives usually include elimination of railroad grade crossings, and the improvement of terminal facilities, to permit orderly urban development.

The urban expressway program has been given nation-wide impetus by the availability of federal funds. Almost all cities have been stimulated to action by the fear that they might lose their fair share of a substantial fund, to which their citizens have contributed through taxes, unless they prepare an acceptable plan. There has been no such impelling stimulation for the solution of urban railroad problems. However, there are notable exceptions to the general indifference to urban rail problems, which serve to encourage those who seek realistic adjustment of rail facilities to fit present-day conditions. Potential gains include relief of traffic congestion, raising of property values, and advancement of the railroads' interests through improvements which allow them to compete more successfully for passengers and freight.

In the City of El Paso, Tex., which has just completed one such major improvement, these promised benefits are already being realized. Other cities such as New Orleans, Beaumont, Tex., and Waterloo, Iowa, are in various stages of development toward comparable railroad improvement programs.

Agreements covering these specific programs have reflected the growth of a more realistic attitude toward financial obligations for such improvements. An attempt has been made to strike a fair balance between the relative responsibilities of, and the potential benefits to, the railroads on the one hand and the cities on the other. In Louisville, for example, the basic principles of financing were agreed to by representatives of the city, the railroads, and the Louisville Area Development Association (now incorporated in the Louisville Chamber of Commerce) before consulting engineers were employed, and it was agreed that: (1) The railroads' share of the cost of grade separations should not exceed 15 percent of the total cost, and (2) the financing of union passenger terminal facilities would be assumed by the city, which would issue revenue bonds to be amortized by rentals paid by the railroads.

Louisville's railroads, industries and real estate subdivisions grew up together in a rough-and-tumble era, as they did in most cities. Restraints on rugged individualism such as city planning were not tolerated. This spontaneous growth produced 188 railroad-highway grade crossings in Louisville, 97 of them main-line crossings, in addition to those eliminated in recent years. Studies were made

therefore, to determine the number and location of needed grade-separation structures.

These studies indicated that, if all traffic were to continue to use surface streets, it would be necessary to separate grades at all main-line grade crossings and at approximately 10 percent of the secondary track crossings by 1970. With the proposed system of expressways, however, the number of grade separations required would be reduced from approximately 110 to only 35, with an additional five existing grade-separation structures to be rebuilt. It was apparent that, without expressways, every available street would have to be used to its full capacity. With a coordinated system of expressways and railroad grade separations, however, traffic could be concentrated on a limited number of arteries with the remaining streets reverting to the only function they are competent to serve—access to abutting property.

One important factor in attracting major industries to Louisville is its excellent railroad service. Most of the large plants have been built along railroad rights-of-way. This distribution of industrial areas affects to a marked degree the logical pattern of expressways. Factory managements want expressways close to their plants so that truck movements can be expedited. Workers want expressways so that their travel over local streets will be reduced to a minimum. City officials want expressways located alongside industrial areas to act as buffers between them and adjacent residential areas.

Another important consideration in route selection is the relationship between expressways and railroad terminals—both for passengers and for freight. The railroad passenger terminal problem in Louisville is very complicated. The three existing stations could be combined feasibly into one new union passenger terminal, with advantages to all concerned. Such a station could be located either on the site of the present Union Station or farther north and west of the central business district. The first location would be about 1,000 ft, the other about 3,000 ft, from the routes of proposed expressways leading to all parts of the metropolitan area.

There are seven railroad freight houses in Louisville handling, on an average, about 275 carloads of inbound or outbound freight per day in less than carload lots. All freight of this type must be trucked over city streets. In selecting expressway routes, we considered the location of present freight houses as well as the new freight depots proposed as a part of our recommendations. The Railway Express Agency handles approximately 2,700 packages per day to or from the three passenger stations. This service generates additional trucking activity, which also must be evaluated in the location and planning of expressways.

More flexibility is permissible in the location of bus and truck terminals than in that of rail terminals. The rapidly growing industries served by trucks are constantly requiring new and better facilities so that the existing pattern did not have much influence on the selection of expressway routes. The converse should not be true, however. The choice of sites for bus and truck terminals should be guided in the future by the proposed expressway routes and the location of access ramps.

Perhaps the most unusual feature of the railroad and expressway system proposed for Louisville is the combination of the two transportation mediums in a single right-of-way on a route extending easterly from the downtown area to St. Matthews, a suburb at the easterly city limits. At present the main-line tracks of the Louisville and Nashville's Cincinnati Division create 23 crossings at grade between the Frankfort Avenue crossing in Louisville and Hubbards Lane, St. Matthews. Rail traffic on this route amounts to 16 scheduled passenger trains and 21 scheduled freight trains per day, exclusive of extra runs. During a 6-year period there were 12 fatal accidents at grade crossings in this section and numerous other accidents resulting in bodily injury, property damage and costly delays to vehicular and rail traffic. Paralleling this track is an important highway, Frankfort Avenue, serving all traffic toward Frankfort and Charleston and much of that bound for Cincinnati. In addition, the highway serves a large and important residential segment of the metropolitan area.

The proposed improvement would place the L. & N. trackage in open cut to the north of the present railroad right-of-way. On completion of this phase of the project, an expressway would be built in open cut between the new tracks and Frankfort Avenue. Multiple-span bridges would carry local traffic across the cut in five locations. In addition to these vehicular overpasses, there would be three single-span pedestrian bridges providing ready access to the bus service as well as to the stores along Frankfort Avenue. Ramps are planned to permit express bus operation, with stops at appropriate intervals.

Bonds for Financing Voted

At a referendum in November 1950, the people of Louisville approved the issuance of $4,000,000 in general-obligation bonds for expressways, $2,850,000 as the city's share toward railroad-highway grade separations, and $5,000,000 for other street improvements. With matching funds from various sources, it is estimated that this local participation is sufficient for a total program costing over $30,000,000. Louisville is now prepared to proceed with the construction of a system of expressways with assurance that these facilities will not block future desirable changes in railroad facilities.

(This article was presented by Mr. De Leuw before the Highway Division session, presided over by Ben H. Petty, M. ASCE, at ASCE's Louisville Convention.)

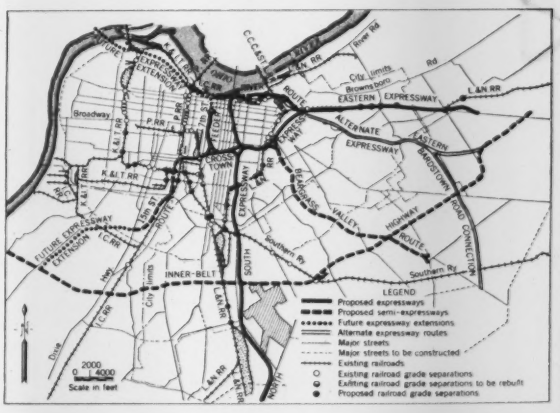


FIG. 1. COMPREHENSIVE city plan prepared for Louisville takes into account vital part railroads play in city's economy as well as need to facilitate flow of vehicular traffic. Coordination reduces number of railroad grade separations which are needed from 110 to 35.

Louisville storm-water pumping station

RAYMOND L. IRWIN, Assoc. M. ASCE

IN LOCATING a storm-water pumping station along the line of a flood wall or levee, the Corps of Engineers generally takes into consideration the location of existing channels or sewers, the economics of collecting the discharge from two or more sewers to a central pumping station, foundation conditions, and the effect of coordinating flood protection with projects of local interests.

In the case of a pumping station of large capacity, when water elevations are above the entrance of a long sewer into the pump sump, it is well to investigate the effect of surges in connection with the pumping operations. Likewise, consideration should be given to the effect of surges caused by a power outage of short duration. Such investigations were made in the case of the Southern Outfall Sewer, which drains over 7 sq miles of a central urban area to be protected by the Louisville, Ky., Flood Protection Project.

The pumping plant, hereafter referred to as the State Fairgrounds Pumping Plant, will handle combined storm runoff and industrial and sanitary sewage. The main sewer, which is quite low with respect to flood stages, is built of reinforced concrete with horseshoe and semi-elliptical sections of varying sizes. The largest section is 15 ft 6 in. × 15 ft 2 in., horseshoe shaped, and 3,247 ft long. The flow from this section enters a sewer of smaller section (10 ft 7 in. × 10 ft 1½ in.) at a point approximately 1,500 ft on the land site of the line of protection. The proposed location of the pumping station is just riverside of the protection line, where the ground elevation is quite high but still below the maximum river elevation of 1937.

Since construction of the sewer in 1910, the system has been extended by the addition of tributary sewers, and the area has undergone intensive development. As a result, the sewer is now overloaded, and even at low river stages intense storms produce damaging gradients. The maximum flow that the existing sewer can deliver to the pumping plant without producing excessive damage has been selected as the planned pumping capacity. The design pumping capacity at the river elevation when the station is put in operation has been determined to be 1,800 cfs. Approximately 33,000 ft of the main sewer will be surcharged when the inflow to the pumping plant is at the design capacity. The velocities in the sewer section near the pumping plant will be about 20 ft per sec.

Since economic considerations require that the sewer system pass through the pumping plant at all times, the head loss would be appreciable if the flow were permitted to enter the sump directly from the 10-ft 7-in. × 10-ft 1½-in. sewer section. Therefore a transition section was proposed to connect the station sump with the sewer, to recover most of the velocity head and thus reduce the gradient in the sewer as low as it was before construction of the pumping installation. To compensate for any head loss through the pumping plant, an additional section of discharge pipe was proposed to supplement the existing drainage facilities between the station and the river. To determine the practicality of these proposals, it was decided to conduct a model study at the Waterways Experiment Station at Vicksburg.

Since the cost of a model of the whole system would be very high, it was decided to have the model represent a section of the main sewer about 10,000 ft long. Along the model sewer a number of risers were added to represent the combined horizontal areas of any manholes or partially filled tributary sewers connecting to the reach which would afford surge relief. If desired, water could be introduced at each riser to simulate tributary inflow to the main sewer. At the lower end of the sewer section a riser or tank was located which corresponded to the pumping-plant sump.

While the model was being constructed, we were busy in the office attempting to obtain a mathematical solution for the same type of sewer system that was being reproduced in the model. The final decision was to use a step method of integration. The derivation of the basic equation for the method is founded on the general laws of motion in a pipe system. The equation of motion can be written

$$\frac{L}{g}\frac{dv}{dt} = H - y - cv^n$$

Results obtained by mathematical analysis checked the model studies within a range of less than 1.5 ft in elevation at the pumping station for a theoretical condition producing a rise of over 65 ft in the station sump upon a complete shutdown of the design flow. Similar consistency between model results and computed data was established for other risers throughout the system.

High or moderately high surges were found to develop under certain circumstances not only from a total shutdown of the pumping plant, but also from a shutdown of individual pump units. It was evident that the pumping plant could be protected from damage due to surges in the sump by the installation of surge relief valves or flap gates that would open and allow discharge direct to the river during high surges. However, because of the low elevation of the sewer system and the topographic conditions, it appeared that some other means had to be found to protect the interior area, which would be below such relief outlets.

A surge relief reservoir was then

designed for surges

Hydraulic Engineer, Ohio River Division, Corps of Engineers, Cincinnati, Ohio

considered, similar to the surge tanks frequently constructed where long penstocks are used at hydroelectric installations. Fortunately, a reservoir site is available adjacent to the Southern Outfall Sewer in the now abandoned channel of Upper Paddy Run, within the Kentucky State Fairgrounds. A reservoir with sufficient storage area to provide effective surge relief can be provided with little excavation by constructing a short levee across the abandoned creek channel. An outlet structure permitting high rates of flow from the sewer into the surge relief area, with small loss of head, also will be required. Investigations indicate that a surge relief area of about 90,000 sq ft can be developed at this site.

Office computations were then made for a hypothetical sewer system representative of the existing sewer system but including a 90,000-sq ft surge relief reservoir. The first 5 min after a complete plant shutdown, the maximum height of surge in the pumping plant sump was computed to be 32 ft. The maximum height of surge in the relief reservoir was computed to be only 4 ft. Computations for the condition where a single pump unit of 386-cfs capacity is shut down, as would occur during normal operation procedure, indicates a rise of 7 ft in the station sump and only 1 ft in the surge relief reservoir. The surge was found to develop in only a few minutes, and it developed more rapidly in the pump sump than in the surge relief reservoir.

Similarly, on starting an additional pump unit, with three units already in operation, a drawdown occurred in the sump which permitted the water there to fall a few tenths of a foot below the elevation proposed to ensure a steady delivery of flow to the pumps. The cutoff elevation for each storm-water unit was designed for operation consistent with this drawdown feature.

Studies indicated that the surge relief area should be used as a remote sump, to control the operations, in order to avoid the effects of false rises in the pump sump due to the surge action resulting from operation of the large pumps. Further, operating cycles of approximately 30 min could be established for each unit as compared to the very short cycle that would occur if the plant sump were used to control operation. The large pumps are to be started manually at predetermined elevations in the surge area, and stopped automatically by a float switch at the pumping plant.

A remote-control indicator, which gives water-surface elevations at the surge-relief area, notifies the operator of the need for additional pump capacity by an alarm system. It is planned that each large pump will have its own auxiliary safety cutoff switch which will operate in the event that excessive trash-rack clogging occurs, such as would allow the water to drop too low for safe pumping.

It is believed that the procedure here described has resulted in a very satisfactory design, which, besides giving adequate protection during flood stages, will provide for a gravity discharge to the river in excess of the existing sewer capacity.

Grateful acknowledgment is hereby made to members of the Ohio River Division and the Louisville District Offices for assistance in making available the material on which this paper is based.

(This article is an abstract of the paper presented by Mr. Irwin before the Hydraulics Division session over which George R. Schneider, Assoc. M. ASCE, presided, at ASCE's Louisville Convention.)

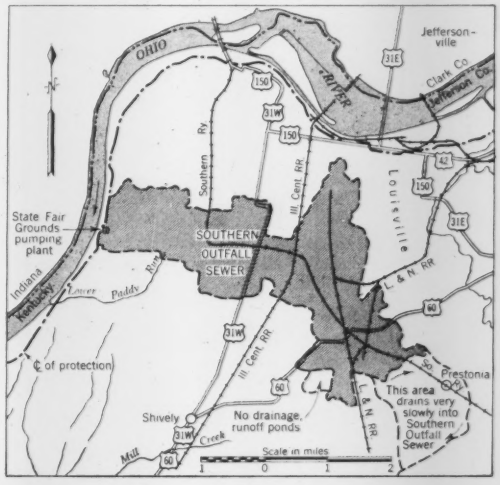


FIG. 1. Location map shows drainage area of Southern Outfall Sewer, Louisville, Ky.

Membership trends influence Society

GAIL A. HATHAWAY, President ASCE, Special Assistant to Chief of Engineers, Office,

FEW WILL DENY that the Society has a responsibility not only to the profession as a whole but also to its own membership. A review of the Society's history cannot fail to impress the reviewer with the great and successful efforts it has always made to live up to its responsibility to the profession as a whole. Nor has it neglected the welfare of the membership. However, in recent years new and acute problems have arisen, especially as regards matters of economic status, and these problems will require continuous and vigorous effort if they are to be satisfactorily solved.

A brief review of membership trends will throw much light on the nature of this problem. First, however, the growing importance of the engineering profession in the national economy should be mentioned. This growing importance is perhaps best illustrated by the change in the number of workers per engineer. In the period 1890–1940, the number of workers per engineer dropped astonishingly—from about 290 in 1890 to 78 in 1940. Since then this number has been decreasing more slowly but it continues to furnish ample evidence of the increasing need for engineers.

It is of interest, also, to compare the growth of the Society with that of the civil engineering profession as a whole. In 1910 approximately 11 percent of all civil engineers were members of the Society. In the 20-year period 1920 to 1940, the percentage varied between 16 and 18 percent. By 1945 it was increasing rapidly, and at present one out of every three civil engineers is a member of ASCE.

Influence of Growing Percentage of Juniors

The most important factor in the Society's growth in recent years is the significant increase in the number of Junior Members (Fig. 1). This rapid increase in Junior Members in proportion to the total membership, ranging from 4.3 percent in 1921 to about 44 percent in April 1951, has in large part been due to the formation of Student Chapters. Principal credit for this growth can be given to the Faculty Advisers and Contact Members appointed by the Director of the District in which the college is located, the Student Chapter Committee, and the assistance provided by Local Sections. Credit must also be given to the professional standing and prestige of the Society in attracting and holding the interest of the young engineer after his graduation. The number of Junior Members dropped from Society rolls during recent years is extremely small. Adoption of a Constitutional amendment in 1947 giving Junior Members the right to vote on Society matters reflected a growing appreciation of the importance of these younger members.

As the proportion of Junior Membership to the total has progressively increased to the present ratio of almost 50 percent, the average age of the composite membership has become correspondingly lower, and the interests and needs of the majority have been changed appreciably by this trend. Most Junior Members are salaried employees, and the majority are destined to remain in the employee classification throughout their careers. The report of the Engineers Joint Council on the 1946 survey of the engineering profession, entitled "The Engineering Profession in Transition," shows that the classification of workers in the civil engineering profession is slightly more than 86 percent employee, including 37.5 percent employed in private engineering and 48.7 percent in public service. The report classifies about 8 percent as employers and 5 percent as independent consultants, the remaining 1 percent being classified as retired, non-engineering, student, and unemployed.

Because the economic welfare of the majority of engineers is thus directly dependent upon the salaries paid for their services, it is logical to expect their professional societies to play a prominent part in assuring that adequate salary scales be established and adhered to. Since a large percentage of engineers engaged in private practice are themselves employers of engineers, it is essential that the fees received by them be adequate to support proper salary payments to their engineer employees and still leave a reasonable profit for services rendered.

To some, this effort to improve the economic status of engineers may seem selfish. However, a broader viewpoint demonstrates that a proper interest in assuring economic returns to engineers in equitable relation to the services they perform is essential to the maintenance of the high level of engineering achievement on which our national economy and way of life so heavily depend. Although many talented individuals would undoubtedly continue to follow the engineering profession in spite of inadequate compensation, records demonstrate that the increasingly unfavorable economic status of engineers in relation to other professions and trades is having a strong influence in reducing the supply of engineers below a safe level for national requirements. Certainly the American Society of Civil Engineers has an important role to play in assuring proper recognition of professional engineers, and in exerting responsible influence to assure that they are fairly compensated, while at the same time protecting the profession and the country against adverse effects that might be expected if engineers should feel impelled to seek economic relief through trade unions.

The situation with respect to nonfederal government employees appears to be the most critical. For example, consider the economic compensation of approximately 20,000

responsibilities

Chief of Engineers, Washington, D.C.

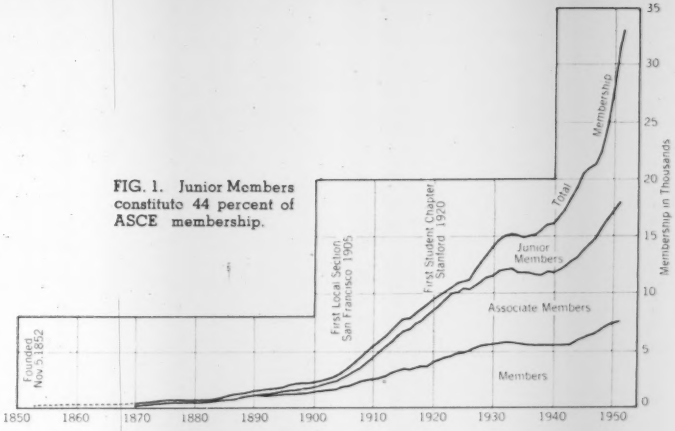


FIG. 1. Junior Members constitute 44 percent of ASCE membership.

professional engineers employed by the 48 state highway organizations. During the fiscal year ending June 30, 1951, it is estimated that these engineers will have designed and supervised the construction of new projects and maintained existing projects involving expenditures in excess of $2\frac{1}{2}$ billion dollars. If country and city projects are included, the value of the work handled would exceed $3\frac{1}{2}$ billion dollars. Yet the economic return to these highly trained professional engineers is surprisingly low. Despite the fact that highway work is such an important service to the nation, only a few states pay their principal highway engineers as much as $10,000 a year. It is estimated that the median salary for professional engineers engaged in highway work in 1950 was $4,200 a year.

Because of these low salaries, the Highway Commissions of the various states are having difficulty in recruiting young engineers and, in fact, are losing talented young men to private industry, which is offering from 30 to 40 percent more in salaries. Similar difficulties with respect to the recruiting of young engineers exist in the federal service.

Work of Engineering Manpower Commission

These difficulties are further complicated by the critical shortage of engineers. Because of this shortage and the absolute necessity of efficiently utilizing engineers during the present emergency, Engineers Joint Council, at the request of the National Security Resources Board, established an Engineering Manpower Commission in September 1950. The objective of the Commission is to develop programs to promote the most effective utilization of the engineering profession in the national interest.

The Commission has made recommendations with respect to the importance of engineering to the national economy, the critical shortage of engineers and engineering students, the Selective Service, Universal Military Service, and extended R.O.T.C. proposals. The Commission has issued a pamphlet on "The Critical Shortage of Engineers," has distributed a leaflet setting forth the salient facts of the engineering shortage to more than 23,000 high school principals throughout the country, and has prepared a pamphlet entitled "Utilizing Engineering Manpower, Deferment Procedures."

To fulfill the requirements of industry and others utilizing professional engineers, it is estimated that a minimum of 30,000 engineering graduates will be needed annually over the next 10 years. Henry H. Armsby, Associate Chief for Engineering Education, U.S. Office of Education, in Circular No. 296, dated June 4, 1951, estimates that the young engineering graduates expected to be available for employment in the engineering field after the requirements of the military services are met, may drop to as low as 12,000 in 1952. From 1954 to 1957 the number will be about 17,000 per year. His estimate is based on current enrollments in engineering colleges, on pre-Korea trends, and on the probable effects of the recently announced Selective Service policies with respect to the deferment of college students.

Thus it is seen that although professional engineers can approach the future with the knowledge that requirements for their services are expanding, many do not receive adequate compensation. It is evident that the Society must give more consideration to the salaries received by engineers. In that connection, I should like to quote a section of the address of the late Henry Earl Riggs, Past-President, ASCE, presented before the annual convention in Salt Lake City, Utah, on July 20, 1938:

"And if it be true that these problems face the profession today, then it is equally true that the profession must speak through its societies. The societies can no longer devote themselves exclusively to matters of technical theory, construction methods and materials, or of design and research. They must give more thought to registration and the enforcement of registration laws; to the merit system in civil service; to proper classification of employees, and not only to the fixing of adequate salaries for each class, but to insisting that those salaries be paid. They will have to give thought to such matters as political discrimination against engineers, unjust discharge, and many other matters that involve the relationships of the engineer employee of city, state or federal government."

These comments apply with equal force today.

Although the Society has continuously maintained high standards of professional ethics and membership qualifications, has contributed greatly to the technical advancement of the profession, and has been effective in many efforts to protect and advance the general welfare of its members, it has not assumed aggressive leadership in formulating and implementing policies for improving the economic status of engineers. I urge the adoption of such a program, knowing full well that it will be conducted in a dignified, professional manner, commensurate with the highest traditions of the Society. Because of the importance of the professional engineer in our social and economic structure, I am confident that proper economic return for his services can be obtained if the problem is attacked vigorously by the engineering profession as a whole.

(This article represents a shortened form of President Hathaway's Annual Address before the Louisville Convention of ASCE.)

Kentucky sewage treatment plants reflect progressive national design trends

J. STEPHEN WATKINS, M. ASCE, Consulting Engineer, Lexington, Ky.

SEWAGE TREATMENT in Kentucky is following the general national trend of making use of the wealth of new equipment and methods resulting from research both in the offices of the equipment manufacturers and in college laboratories. The impetus given to the construction of new sewage treatment plants in this state also reflects the national awakening to the need for adequate treatment of municipal wastes. The formation of the Ohio River Valley Water Sanitation Compact (ORVWSC), of which Kentucky is a member, has had a definite influence on the thinking and planning of both civic officials and sanitary engineers.

Primary Treatment Pushed for Heavily Polluted Streams

Because of the large number of treatment plants needed in the state, initial efforts are being directed toward primary treatment so as to provide earlier relief for heavily polluted streams. In the case of smaller streams, where sewage is a large percentage of the total flow, complete treatment is being provided.

Grit chambers and shredders have come into general use in both primary and complete treatment plants. While these processes do not improve the plant effluent, they do eliminate many operating difficulties that are both unpleasant and uneconomical. In particular, they tend to eliminate clogging of sludge lines and the compaction of grit in sludge tanks—also wear on equipment.

The use of pre-aeration tanks has been given increased attention by designers in this area. The reason is to be found largely in the rulings of the ORVWSC, which permit the construction of primary treatment plants if facilities are included for chemical treatment during periods of low river flow. Pre-aeration tanks are well adapted to this arrangement, as they provide standard pre-aeration treatment, with its attendant benefits, during periods of normal river flow, and also allow the basin to be used as an air-flocculation chamber when chemical treatment is required.

For the smaller installations, sedimentation tanks of the two-story Imhoff-tank type, are still being designed and used. In the large installations, plain settling tanks provided with mechanical equipment for sludge removal are in general use. In settling tanks, engineers are giving more thought to means of preventing or minimizing short circuiting to secure better efficiencies. Interest has been evidenced in longer effluent weirs and the location of weirs away from the walls of the tanks.

Trickling Filters vs. Activated Sludge

Where complete treatment is indicated, the present tendency in this state is toward the use of trickling filters rather than the activated sludge process. The trickling filter plant has clearly established its ability to provide a satisfactory effluent both where the chemical and biological characteristics of the sewage change rapidly and where heavy overloads occur for short periods. This ability is felt to be highly important in small to medium-size plants where adequately trained operating personnel are not available. Trickling-filter installations of both standard, or low-rate, and "high-rate" design all meet with favor with most designers. However, the trend since World War II has been toward "high-rate" filters with recirculation ratios of from 1.33 to 1, to 2.5 to 1. Since World War II, 86 percent of all filters constructed in the state have been "high-rate."

In plants employing sludge digestion, it is almost universal practice to cover the digesters and to collect the gas for use in heating the tanks. The tendency in the design of these tanks is to follow the many improvements in digester design that have been devised during the past few years. Among such improvements are the use of external heat exchangers, the

TABLE I. CAPACITIES AND COSTS OF NINE RECENT SEWAGE TREATMENT PLANTS

	Location	Design Capacity, gpd	Year Constructed	Construction Cost*	Treatment Method
Plants completed:					
1	Berea, Ky.	350,000	1938–1939	$ 58,659.41	
2	Middlesboro, Ky.	1,170,000†	1938–1939	144,602.47	
3	Lebanon, Ky.	300,000	1940	52,094.08	
4	Georgetown, Ky.	400,000	1947–1949	95,334.27	Standard-rate filters and separate sludge digestion
	Digester added		1950	13,850.00	
5	Mt. Sterling, Ky.	450,000	1948–1949	142,166.25	
6	Franklin, Ky.	350,000	1949–1950	135,075.43	
7	Glasgow, Ky.	864,000	1949–1950	216,000.00	
Plants being designed:					
8	Northern Kentucky Sanitary Dist.	26,800,000		1,600,000.00	Primary treatment with incineration of sludge and provision for chemical precipitation
9	Clarksville, Ind.	1,000,000		175,000.00	Primary treatment with separate sludge digestion and provision for chemical precipitation

* Does not include land, design fees, or supervision cost. Figures given for first seven plants represent final construction cost. Cost of Northern Kentucky Sanitary Dist. plant is two-year-old estimate. Cost of Clarksville plant is preliminary estimate.

† Includes provision for 90,000 gpd tannery waste, not yet connected.

Note: Plants Nos. 1–6 were designed and construction was supervised by J. Stephen Watkins, consulting engineers, Lexington, Ky. Plant No. 8 is being designed by the same firm, as consultant on design, and Plant No. 9 is being designed by J. Stephen Watkins & Robert E. Martin, consulting engineers. Plant No. 7 was designed, and its construction supervised, by Howard K. Bell, consulting engineers, Lexington, Ky.

Design Practice for Kentucky Sewage Treatment Plants

54% of all plants use hand-cleaned bar racks (1 is mechanically cleaned).
38% of all plants use grit chambers.
35% of all plants use comminutors.
70% of primary settling tanks have mechanical sludge-removal equipment.
20% of secondary settling tanks have mechanical sludge-removal equipment.
41% of secondary plants use flocculating equipment.
60% of all types of filters are "standard rate."
31% of all types of filters are "high rate."
9% of all types of filters are contact beds.
84% of "standard-rate" filters have rotary distributors.
16% of "standard-rate" filters have fixed nozzle distributors.

STANDARD-RATE FILTERS and separate sludge digestion are provided by sewage treatment plant at Berea, Ky., built in 1938–1939. Capacity of 350,000 gpd was provided at cost of about $58,660, exclusive of land, design fees, and supervision.

spacing of sampling pipes at closer vertical intervals, and the provision of sufficient supernatant draw-off connections to allow for adequate handling of scum problems. In general, the tendency has been to get away from the use of earth embankments around digesters and to use brick with a dead-air space to provide insulation.

All sludge beds (except one) are open in this state—a deviation, perhaps, from the national trend. One reason for this practice may possibly be the feeling of designers that during the many months of high humidity experienced here, sludge under glass will not dry any better than that exposed to the elements. In the general design of sludge beds, little improvement has been noted in recent years.

It is expected that, with the increased construction of sewage treatment plants, incineration of sludge will make headway in this state. It is probable that complete incineration will be practiced, rather than sludge drying for the purpose of making fertilizer. While it is probably true that city governments would look upon the selling of a by-product as good business, the attendant difficulties of putting plant personnel in the fertilizer business would soon outweigh the financial advantages, if any.

Use of Chlorine Well Established

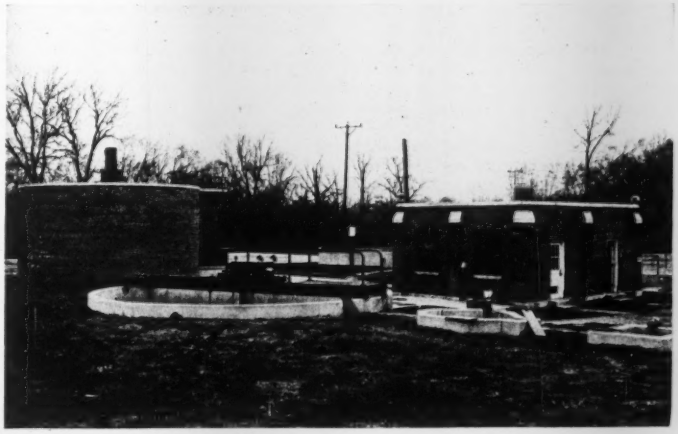
The place of chlorine in sewage treatment plant design is of course well established. The present tendency in the state is to provide as many points of application as possible throughout the entire plant.

As previously mentioned, the influence of the ORVWSC has been felt in the increased emphasis on the use of chemical treatment in primary treatment plants. Present thinking favors the use of lime and iron in their several forms. Ferric sulphate and hydrated lime are given first consideration, particularly for the smaller plants, while in the larger plants unslaked lime is preferred.

Appreciation is expressed for the help given by Robert E. Martin and Robert P. Johnson in the preparation of this paper.

(This article is abstracted from the paper presented by Mr. Watkins before the Sanitary Engineering Division session, presided over by B. A. Poole, M. ASCE, at ASCE's Louisville Convention.)

SEWAGE TREATMENT PLANT of 400,000-gpd capacity at Georgetown, Ky., built 1947–1949 for about $95,000 (not including land, design fees or supervision), has standard-rate filters. Digester was added in 1950 at cost of $13,850.



Jet planes spell trouble building

ROBERT W. LOCKRIDGE, Lt. Col., CE,

AVIATION ENGINEERS work to lengthen runway somewhere in Korea. Often planes make landings just over the heads of crews laying landing mats of pierced steel planking.

LIGHTED FOR round-the-clock operation, (left) a Fifth Air Force 2-cu yd shovel bites into a Korean hillside to provide earth and rock fill for a rice-paddy airfield.

SHARP CONTRASTS mark Korean terrain, (right) where steep hills rise from flooded rice paddies. Not all fill material is loaded by power shovel.

AVIATION ENGINEERS have tackled new problems in airfield construction in Korea with the same ingenuity that has furthered engineering progress everywhere. Advancements in aircraft design have given engineers in Korea some of their biggest headaches. The difficulties posed by large planes with heavy loads were easily solved by lengthening runways. But the jet-propelled tactical war planes of the Fifth Air Force spelled trouble for the constructors of airfields.

At first the terrific blasts from the jet tailpipes dispersed the dirt foundations under the pierced steel planking of the landing mats. Normal layers of dirt and rock disappeared under the pressure. The jets continued to wreck the runways even after a layer of asphalt was put under the planking. High-powered jet fuel dripped on the runways, softened the asphalt and the tailpipe blasts scattered the base again. A minimum 2-in. layer of asphalt under the planking is now being used with the hope that the added thickness will hold the raveled asphalt until the jet fuel dries. Another solution tried with good results is to apply a layer of coal tar over the asphalt. Coal tar is not soluble in jet fuel.

Low-slung jets carrying napalm present other engineering problems. The napalm tanks under the planes' wings leave a clearance of only 3 to 4 in. The slightest irregularity or bump in a runway causes the tanks to scrape and explode. Therefore the runways must be constructed to achieve table-top smoothness.

Jet aircraft also have a slower rate of acceleration than propeller-driven planes, necessitating longer runways than were used in World War II. In some instances, take-off and landing runways must be doubly lengthened to accommodate heavy ordnance loads of rockets, 1,000-lb bombs and 0.50-caliber ammunition.

The enormous fuel consumption of jet aircraft has made it necessary to build most bases near waterways so as to permit fuel to be brought in by boat. It is impracticable to construct the extensive storage and distribution systems required to keep a jet fighter group supplied with fuel by land transport. Fuel problems have increased tenfold since World War II.

Korea's mountainous terrain is undoubtedly the chief obstacle in building air strips. Most of the Korean flatlands are covered with water-flooded rice paddies. The old procedure of draining only the runway was found to be insufficient. Instead, all the surrounding areas must be ditched and drained.

Rice paddy land has taken its toll of heavy equipment also. The big machines sink into the soggy ground and are almost buried. Roads often must be manually constructed before heavy equipment can move in with safety.

The high water level, torrential rains and an average California Bearing Ratio of 3 throughout most of South Korea forced an increase in the depth of fills on the rice paddies from the normal 12 in. to as much as 35 or 40 in. This additional depth causes considerable extra work since the only suitable filling is rock, which has to be blasted and trucked from the mountains. Initial rock filling by Korean laborers using ox-drawn carts is usually done to prepare solid working areas for heavy equipment. As soon as the heavy equipment moves in, the production speeds up, but the water table must always be lowered before machinery can be effective in the rice paddies.

One base, located at the foot of a mountain, had to be completely surrounded with a series of ditches to hold seasonal rains back from the runways. Sparse vegetation on the mountainside failed to hold the rain. Another base, facing the Sea of Japan, has a set of water gates and dikes to combat rain. At low tide the gates are opened to drain the field. At high tide they must be closed and the water drained off with a pumping system. At this same base, pierced steel planking was laid as deep as 6 ft down to provide a stable foundation for the fill. Asphalt was spread over the base material and a double

for aviation engineers

Korean airfields

Director for Installations, Headquarters, Fifth Air Force

KOREAN MEN, women and children gang up to fill bomb crater too small to accommodate a roller. Brick foundation is tamped with sections of telephone poles to which handles have been attached.

OX-CARTS and heavy American army equipment (left) function together at an advanced air base in Korea to supply fill for a new runway.

DOUBLE THICKNESS of asphalt sprayed on runway (right) protects it against torrential rains and terrific blasts from tailpipes of jet planes.

layer of steel matting laid on top. Even with these special precautions, the section is beginning to settle since it is at the end of the runway, where it receives maximum loading from landing planes.

Poor Korean roads plague the engineer units when they move from one site to another. In most cases roads are built as each movement takes place. Occasionally an operating airfield is located near enough to a proposed site to make the airlift of equipment practical, but this is rare.

Harassing action by guerillas, a hazard experienced during World War II, has caused added trouble in Korea since the mountains provide natural shelter for snipers, and infiltration is common. North Koreans are often discovered in labor gangs. These infiltrators are usually captured before they can do any damage, but on occasion, production schedules have been held up by sabotage.

In the first weeks of the war, engineers constructing an airfield on Korea's east coast were forced to work in total darkness after some of their men were hit by sniper fire. Enemy mortars from nearby hills continually dropped shells on the runway and the engineers were often called into action as combat troops to defend the installation. When the base was finally evacuated, engineers-turned-infantrymen fought the rear-guard delaying action.

Most bases that have been evacuated by, or recaptured from, retreating Reds are mined and dotted with booby traps. Mine clearing details give such areas a quick check to enable ground troops to move up, but there is still the danger of overlooked and bypassed mines.

Utilization of native labor is a "must" in Korea. Koreans have proved themselves masters of improvisation. In one instance when rollers were not available, they made tampers out of 4- or 5-ft sections of telephone poles, upended, with four handles nailed to the sides. Four men, each taking a handle, lifted and dropped the pole until the dirt was packed. Often women and children were added to the labor force.

Coolie style, the Koreans carry everything possible on their backs. Using an A-shaped framework with shoulder straps, they can carry loads up to 200 lb. These A-frames are used for everything from transportation of household goods to carrying little children.

For their outstanding work in Korea, three engineer aviation units have been awarded the Presidential Distinguished Unit Citation. As they meet and overcome such problems as have been described, the aviation engineers in Korea are writing a new page in the annals of engineering, and in their own proud history.

AGE-OLD DIRT-MOVING methods replace engineers' equipment wherever soggy ground stops heavy trucks. Refugee Koreans, forming labor gangs, carry rock and dirt on A-frames strapped to their backs. Below, swarms of ox-carts haul fill.

Joint highway-railway military planning should remain in state and private hands

THE MOST effective way to keep this country's transportation networks at maximum operating levels, in readiness for any military need that might arise, is to leave the responsibility in the hands of experienced existing agencies, namely, the state highway departments for the highways and the railroad companies for the railways. The former should function under the supervision of the Bureau of Public Roads and the latter under the Interstate Commerce Commission.

Military operations in these times depend for success on the performance of transportation. Perhaps they always have, even when soldiers were marched on foot across country and supplies were hauled by horses and mules. But in modern warfare, transportation is more in the spotlight because of current mechanized methods and equipment. Horses and mules came into the military picture as far back as Alexander the Great, Hannibal, and Caesar, and remained the sole mode of transport up until the Civil War in 1861. Washington's transportation facilities were no better than Hannibal's; the situation had remained the same for 2,000 years.

First Use of Railroads in War

In our Civil War, for the first time in the history of warfare, railroads were used to some extent. They were also used in the Russo-Japanese War of 1905. In World War I, with the installation of the internal combustion engine in trucks, tanks, and airplanes, war took on a new aspect. World War II firmly established modern mechanized transport as a tool of war.

Except for the theaters of operations, railroads carried the bulk of our tonnage. German railroads carried on right in the thickest of the fighting, because of the lack of motor fuel. Motor trucks carried the bulk of the load for the Allies in the actual fighting zones. Tanks and armored cars replaced cavalry, and to some extent infantry, and infantry divisions were moved in motor trucks whenever any distance had to be covered.

As a general rule, as fast as the Allies captured territory, they started rehabilitating the railroad lines. All bridges were demolished by the retreating enemy and all make-up yards were destroyed by our air force. Motor trucks hauled supplies to the front from rear supply bases until another section of railroad could be put back in service. Then the rail head and truck head moved forward and the performance was repeated. Every bit of transport capacity was needed, and the railroads relieved the trucks as fast as possible.

With this background from World War II, let us start to lay our plans for highway and railway transportation facilities in the United States to serve as a strategic network in case of military action in this country. It is evident that both rail and highway systems are vital. Today we have both to an extent greater than any other nation, but they must be integrated for military purposes. Because of the great size of the country geographically, it will never be economically possible to have four-lane pavements on every section line or even to approach such a capacity. Under present conditions, the railway mileage will not be appreciably increased. Some new mileage will be built to serve industries, but other mileage on branch lines will be taken up so that the total mileage will remain substantially unchanged. Therefore we must plan to use both the highway and the railway nets to their utmost capacity in the event of actual war on this continent. In World Wars I and II, the United States was given a year or more to get ready to enter the conflict. I doubt that such a situation will occur again. An enemy with an ounce of sense would bomb American industry at the very beginning of war. They would do the maximum damage to our industry in the first few hours, before our defense arrangements could become fully effective.

Highway Planning by States

Joint highway-railroad military planning must be done to a greater extent by civilian civil engineers and less by members of the Corps of Engineers. Corps officers must be spared for combat engineering operations, for which they have been especially trained. There need be no great apprehension about joint planning if it is approached sensibly and the work left in the hands of those best fitted for it, namely, the highway departments and the railroad companies.

One practical approach to joint highway-railroad military planning would be by states. Each state has a highway department or commission,

JOHN W. WHEELER, M. ASCE

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ON ALCAN HIGHWAY, 40-odd private contractors under writer's direction showed ability to get heavy grading and bridge building done under adverse conditions, using modern equipment. Engineer troops also did masterful job, chiefly in pioneer clearing and rough grading.

and a public service or railroad commission. In these two offices in each state capital are all the data on the entire highway and railway network in that state. These two organizations know intimately the needs of transportation within their area. They know what additional highway mileage is needed to serve the new war industries located in their state as well as the rail-line extensions required for new industries.

Naturally each state could not go its own way without considering the over-all transportation pattern. Fortunately there are two existing experienced federal agencies, with excellent records in handling transport, which could easily coordinate the networks on the basis of national need. The Bureau of Public Roads has cooperated with the state highway departments for a third of a century and could easily carry on through war. Similarly, the Interstate Commerce Commission has regulated the railroads for over half a century and could continue to handle them in time of emergency. The great benefits resulting from having state highway departments and railroad companies, and the Bureau of Public Roads and the Interstate Commerce Commission, remain in control of transportation is that experienced people would continue to function. If these means of transportation were taken over by the Army, new and green personnel would immediately be put in key positions, and confusion would result.

When I say that the state highway departments should carry the load of highway maintenance and repair during a war, I mean that these departments should use the highway contractors of their states to their fullest capacity. These contractors have organizations of trained road builders and great quantities of excellent road-building equipment and machinery. Why should the Army try to maintain and repair highways when the states have such a favorable setup?

The railroad companies, with their own organizations and equipment, plus the organizations and equipment of the railroad contractors, could maintain and repair the railways in the same manner suggested for the highways.

Alcan Highway Is an Illustration

In support of the view that contractors working under the direction of the state highway departments would do the work faster and better than any other agency, let me cite my experience on the building of the Alcan Highway. It was my fortune to be the officer in charge of its construction, and as such to be in command of the Engineer troops on the road. The 40-odd contracting outfits were also under my direction. It is true that the troops did a masterful job of pioneer clearing, bridge building, and rough grading, but the bulk of the heavy grading and bridge building was done by the contractors working with modern equipment The esprit de corps of these contracting outfits was excellent. Their ability to carry on under adverse working conditions, and their high output convinced me that the use of contractors surpasses all other methods in getting work done. Contractors experienced in railroad work could do the same for the railways.

Such a plan is not new or untried. The German army did not try to do its own highway and railway work. The famous Todt organization, under its great engineer, Dr. Todt, did the engineering and construction for the Wehrmacht. The engineer troops of the German army were left free to operate as combat troops.

Recommendations

Summing up the problem of joint highway-railway planning. I would recommend: (1) that the state highway departments and the railroad companies be instructed to put their facilities in readiness for such an emergency as would follow the commencement of hostilities on this continent; (2) that the Bureau of Public Roads and the Interstate Commerce Commission be instructed to ascertain if this planning is being carried on in such a way as to facilitate interstate transportation—both highway and railway; and (3) that one person be named to control all transportation under the Bureau of Public Roads and the Interstate Commerce Commission. This plan is simple, direct, and workable, because it continues the present agencies in the work to which they are accustomed and creates no new, conflicting, or untried organizations.

(This paper, here abstracted, was originally presented by Mr. Wheeler before the Highway Division Session, presided over by Ben H. Petty, M. ASCE, at the Society's Louisville Convention.)

Skunk River Bridge exhibits composite

Tests reveal unexpected bond between concrete floor and steel stringers

ALMON H. FULLER, M. ASCE, Professor of Civil Engineering, Iowa State College, Ames, Iowa

IMPACT TESTS made on the Skunk River Bridge in 1922–1925 gave evidence of composite action between the stringers and the reinforced concrete floor slab. This evidence was generally accepted, but there was doubt as to how long such composite action would continue under service conditions. The bridge was then new, having been opened to traffic in 1921. (See Bulletins 63 and 75 of the Iowa Engineering Experiment Station for reports on this cooperative research by the Station, the U.S. Bureau of Public Roads and the Iowa State Highway Commission.)

When in 1948 the bridge was declared inadequate for modern traffic, largely because of clearances, and was slated to be moved to another location on a secondary road, an opportunity was presented to make a brief exploratory investigation on the bridge to determine whether there was still evidence of composite action between stringers and floor slab.

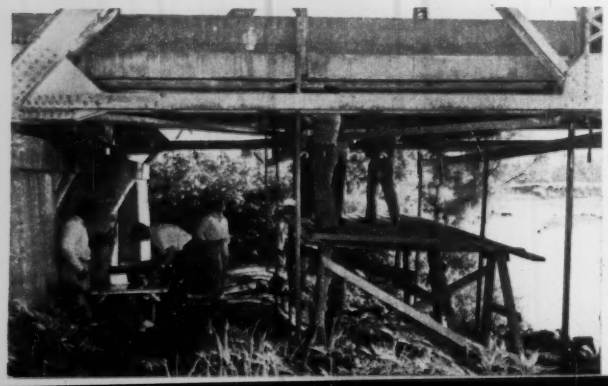
The 1922–1925 investigations included tests on two sections of the bridge, the west panel of the truss span and the west approach span (Fig. 1). These same two sections were chosen for the 1948 tests. A photograph shows the truck trailer used for the 1948 loadings. In the 1922–1925 tests, the live load was a Liberty truck loaded with gravel so that the total weight was about 15 tons, with 12 tons on one rear axle.

In 1948, strains in the stringers were measured by different types of instruments. A Baldwin-Southwark portable strain indicator with a switching unit for 22 connections and a 6-channel oscillograph were connected with individual SR-4 gages. Five extensometers of 20-in gage length, with Last Word dials, were connected to the beam flanges. The strain indicator provided the only means of reading all the stringers; the oscillograph and the five extensometers, distributed among the stringers and one floor beam, served as checks, and as a means of appraising the reliability of the tests as a whole.

Deflections for all loads were read by eight Federal 0.001-in. dials working between the bottom flanges of the I-beam stringers and a reference beam supported from the ground, independent of the staging for the operators.

Individual strain readings were taken at the center line of each stringer on each side of the top of the bottom flange, and, for a few stringers, on the bottom of the top flange. Unit stresses were computed from deflections under two extreme conditions—whole load carried by stringer, and full composite action between stringer and floor slab. The correct stresses naturally lie between these extremes.

Stresses computed from deflections when the steel alone was considered to carry the load were less than those computed from the strains, and stresses based on full composite action



FOR TEST READINGS on west panel of center span, deflection equipment was set up on under side of stringers, with wires to SR-4 strain gages. Strain indicator and oscillograph were on tables close to pier, at left. Current for instruments was provided by motor-generator set on truck. These field measurements were made on three mornings in June 1948, between 4:00 and 8:00 o'clock.

action after twenty-eight years of service

were greater than those from the strains. For the approach span the differences were not great, and the two sets of stresses from deflection may be considered as the limits of a band within which the actual stresses lie. For the west panel, the deflection stresses for steel alone were reasonably close to those from strains, while those computed on the assumption of full composite action were very much greater.

The ratio of the load transferred to the maximum stressed stringer to the total load was determined as the unit stress in the one stringer compared with the sum of the unit stresses in all the stringers. For the 1948 tests, these ratios were 0.18 and 0.19 with the load on the side of the roadway, and 0.15 and 0.17 with the load on the center line. The 1925 results were from 0.23 to 0.25 for the load on the side, and 0.17 and 0.19 for the load on the center line. The value computed from the specifications is 0.21. Thus in 1925 the load on the maximum stressed stringer was greater than that allowed by the specifications, and in 1948 it was less. The differences may be attributed to at least two factors—difference in type of trucks used for loading, and difference in the thickness of the concrete floor, which was 6 in. in 1925 and 9 in. in 1948.

Observed and computed unit stresses in stringers are compared in Table I. It should be mentioned

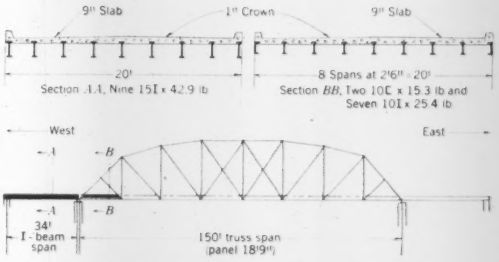
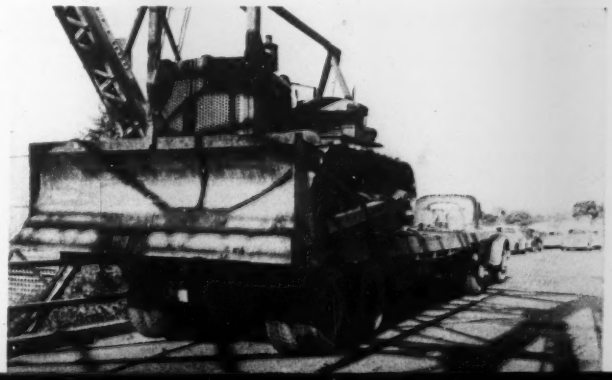


FIG. 1. ELEVATION and cross sections of Skunk River Bridge, on Lincoln Highway near Ames, Iowa, show main features of design. Reinforced concrete floor, originally 6 in. thick, was increased to 9 in. in 1929. No mechanical bond was provided but conctete extends a little under top flange, about 1 in. below top of steel. Sections tested both in 1922–1925 and in 1948 are shown in heavy lines.

TABLE I. OBSERVED AND COMPUTED STRESSES, IN PSI
Developed in 1948 Tests by Given Load Chosen on Basis of AASHO Specifications

Type of Fiber Stress	Stringer in Approach Span	Stringer in West Panel, Main Span		
		Simple beam	Fixed ends	Probable end restraint
Computed:				
Bottom flange:				
Steel only	9,800	15,600	6,100	11,500
Full composite action	4,900	5,400	2,100	4,000
Top fiber concrete:				
Full composite action	350	400	160	290
Horiz. shear between steel and concrete, full composite action	90	...	...	300
Observed:				
Bottom flange	3,500		6,200	
Top flange	±0		4,900	



LOADS IN 1948 TESTS consisted of 17,150-lb. truck trailer carrying 34,700-lb track-laying tractor which could be moved on truck to vary axle weights. Only wheels of two rear axles were on span. Longitudinal position was about that for maximum moment, and three transverse positions were used—north wheels against north curb, south wheels against south curb, and wheels centered in roadway.

that visual observation showed the concrete around the top flange of the I-beams on the approach span to be sound, whereas it was broken in many places on the west panel.

These tests were subject to the same limitation as most previous ones—inability to secure, or to move over the highways, a load sufficiently great to develop full unit stresses in the structure. Within the limits of the available live load, the results indicate that the stress in the steel stringers in each span was decidedly less than would have been developed in the steel acting alone as simple beams. Although no mechanical bond had been provided, the reinforced concrete floor evidently contributed in some manner.

In the approach span the evidence points to definite (if not full) composite action even though the span had been in use for 28 years under heavy traffic. In the west panel the measured strains and deflections and the slight cracking of concrete around the flanges of the stringers indicate but little direct action between concrete and steel. Yet the low stresses in the stringers suggest that they are getting help. The resisting moment from the steel reinforcement in the floor slab and from the stringer to floor-beam connections could provide about the necessary amount of help.

Although these deductions may reflect correctly the small unit stresses developed by the available live load, no information is available for extending the results to fully loaded structures. No general conclusions should be drawn from an exploratory research as brief as this, but it may serve as a basis for further discussion and research. The following questions, in particular, may be deserving of consideration:

1. In future design of simple beam spans, should composite action be assumed, or is the present tendency to supply mechanical bond a wise one?
2. In future design of continuous beam spans, including stringers in truss spans, should the continuous action of a reinforced concrete floor be recognized? If so, to what extent?
3. Do other old bridges, like this one, have unexpected reserve strength, and in appraising this, is it wise to limit their load-carrying capacity to the additional unit stresses recognized in the specifications?
4. Would a more extensive investigation of existing spans, especially those that are reaching their rated capacity, be economically justified?
5. Would research on models of old and modern beam spans be economically justified?
6. What loading would be practicable for further tests of the Skunk River Bridge? Would tests to destruction on one or more of the panels be justified? Also tests to near the elastic limit on some truss members?

Can reliance be placed on natural bond between concrete and steel?

E. W. BLUMENSCHEIN, Bridge Engineer, Iowa State Highway Commission, Ames, Iowa

BACK in the early twenties when Professor Fuller conducted his impact tests on the Skunk River Bridge east of Ames, and on two other bridges inside the present city limits of Ames, an impact factor on highway bridges was just beginning to worry designers. Aside from impact findings, the evidence of those tests was conclusive that joists on all three bridges tested developed composite action with the concrete floor. Since that time composite beam design has made great strides because of the economies effected. At present, however, little reliance is placed on the bond of the concrete to the supporting steel. In 1944 for the first time, the American Association of State Highway Officials included a design section on composite beams in their bridge specifications. Full transfer of horizontal shear by mechanical means is required.

The literature abounds in examples of composite beam action, some with and some without mechanical anchorage. There is, however a dearth of published reports in this country on bond behavior in composite sections after a period of service. Professor Fuller's 1948 tests fill a great need.

Average daily traffic over the Skunk River Bridge in 1949, as reported by the Safety and Traffic Department of the Iowa State Highway Commission, was 686 buses and trucks and 3,161 passenger cars—an hourly average of 160. In 1934, the earliest year for which data are available, the report was 422 buses and trucks and 1,934 passenger cars—an hourly average of 98. Undoubtedly the data for 1922 to 1925 would show a much smaller figure.

Especially interesting is the marked difference in the behavior of the approach span and the floor of the west panel of the truss span. All the evidence indicates that there is still perfect bond between beam and slab and true composite action on the approach span. The computed bottom-flange stress, assuming composite action, is given (Table I) as 4,900 psi, while the observed or measured stress is 3,500 psi. Is this discrepancy excessive? I believe not. If the computations had been based on more realistic specifications, the computed stress would be much nearer the observed stress. For instance, we all know that tandem axle loads, instead of falling solely at concentrated points, result in an appreciable longitudinal distribution of wheel loads. In place of frictionless hinged end supports of a span, there is a certain fixity. The concrete curb, being attached to the floor slab and acting as a monolith with it, has an appreciable stiffening effect.

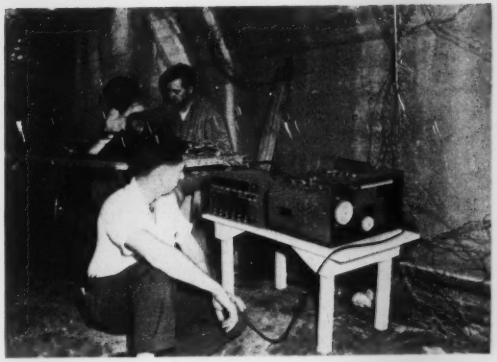
Again, the observed stress in the top flange is zero, which is in close accord, for full composite action, with the neutral axis for live loads near the junction of slab and beam flange. Furthermore there is no visible evidence of slip along the junction line.

In the truss panel, the behavior of the floor slab definitely indicates bond failure between the slab and the beam flange. Here the supporting beams are only 10 in. deep instead of 15 in. as on the approach span. For complete composite action, the neutral axis would fall about $2^1/_2$ in. *above* the bottom of the slab, and under live load the entire beam would be in tension. The observed stresses, however, show a tension of 6,200 psi in the bottom flange and a *compression* of 4,900 psi in the top flange. The inference is that there has been total bond failure. The partial composite action indicated by the smaller observed stress in the top flange than in the bottom flange can readily be explained by the frictional resistance of the gritty slab sliding on the top beam flange. The observed flange stresses place the neutral axis about $^1/_2$ in. above the center line of the beam—a long drop from its initial position up in the slab $1^1/_2$ in. above top of beam.

Why should there be bond failure in the main truss span and not in the approach span? In looking for the answer to this question it is hardly necessary to go beyond Professor Fuller's report and the difference in the design of the two spans. The horizontal shear at the end of the approach span is reported as 90 psi over the top flange area, and this shear of course diminishes toward the center of the span. Assuming a safe design bond value of 100 psi for concrete deposited against a fairly smooth steel surface under favorable conditions, the design is conservative. The particularly favorable condition in this case is the concrete end diaphragm 15 in. in horizontal dimension, which was placed monolithically with the floor slab, filling the space between the beams down to the bridge seat. This end block forms an extra anchorage for the end of the beam and effectively prevents curling of the slab.

On the main truss, conditions are different. The reported computed horizontal shear, or bond value between steel flange and concrete, for composite action, is 300 psi. This is far above our assumed safe value of 100 psi for favorable conditions. In defense of this rather arbitrarily chosen safe value, reference is made to "Bond of Concrete Reinforcing Bars," by Arthur P. Clark (with National Bureau of Standards), Journal of the American Concrete Institute, November 1949. Mr. Clark reports a bond value of about 200 psi for plain round bars. A factor of safety of two appears reasonable.

In addition to the excessive bond stress, there is no redeeming end anchorage as on the approach span, and in consequence slab curling or humping will contribute to the early and progressive bond failure. Elongation of the bottom chord and deflection of the stringers under live load produce visible or invisible transverse cracks over each transverse floor beam. At the same time the longitudinal floor reinforcement, by producing some end fixity of joists, actually hastens bond failure. When the bridge was first opened to traffic these joists acted as composite beams. As recurring heavy loads were applied, bond failure progressed from the ends of the stringers toward the center line. How long it took to produce complete bond failure is conjectural.



IN 1948 TESTS on Skunk River Bridge, strain indicator and oscillograph were set up on tables close to concrete pier. B. R. Sen and C. D. Handforth are at strain indicator, in background, and R. T. Othmer is at oscillograph in foreground.

It is believed that the condition of the west panel of the main span is not representative of the structure as a whole. There may be three reasons why this is so:

1. The severe impact tests with solid rubber tires passing over obstructions, which were conducted on the bridge in 1922–1925, were confined to this panel.
2. The roughness of the floor expansion plates at this end of the span produce greater impact than at any other place on the span.
3. A visual inspection shows the concrete to be in much better condition in all the other panels of the main span.

If the 1948 tests had been conducted on any other panel except this one it is likely that they would have shown considerable composite action, although there are indications that bond failure near the ends of the stringers is developing throughout.

Speaking from the designer's point of view, it seems safe under favorable conditions to assume full composite action even though no formal mechanical shear developers are used. The important conditions to be met seem to be:

1. Keep bond stresses low, probably not over 100 psi.
2. Provide details to prevent curling or humping of slab, particularly at points of maximum shear. End diaphragms cast monolithically with the floor seem very effective. For long spans similar intermediate diaphragms might be considered.
3. When in doubt, use mechanical shear developers. These devices should be designed to prevent uplift of the slab such as occurs with curling.

In conclusion, the immediate practical benefits to be derived from this 25-year check-up on a patient still in the prime of life so far as giving service is concerned, should be stressed. There are literally hundreds of simple I-beam spans with concrete floors scattered over the State of Iowa, all very similar to the approach span of the Skunk River Bridge. Spans of this type can readily be widened if they meet load requirements, and a competent visual inspection will reveal whether there is still full composite action. For such patients, retirement should still be far in the future.

For types other than simple beam spans now in service, the determination of whether there is composite action becomes more difficult. Visual inspection is still the first tool. In doubtful cases, strain-gage measurements of top and bottom beam-flange stresses under a known heavy live load would give a valuable check.

For the student (all of us, I hope) the most important lesson to be gleaned from this review is that there may or may not be composite action in service. It either exists or it doesn't; there seems to be no safe middle ground. Further studies can advance our present meager knowledge of the nature of composite action under service conditions. The pattern for such research seems pretty well established in the case history of the Skunk River Bridge.

FEBRUARY STORY CONTINUED

JOHN N. NEWELL, Chief Engineer, Massman Construction Co., Kansas City, Mo.

Floating caissons for Yorktown, Va., bridge

THE PROBLEM confronting the contractors in building the deep foundations for the bridge over the York River near Yorktown, Va., was the sinking of six large caissons to a maximum depth of 150 ft below mean sea level. A general description of this project (Fig. 1), known as the George P. Coleman Memorial Bridge, was given in the February 1951 issue of CIVIL ENGINEERING by Maurice N. Quade, M. ASCE, and George Vaccaro, Assoc. M. ASCE, respectively partner and project manager of Parsons, Brinckerhoff, Hall and Macdonald, the New York consulting firm responsible for the design and field supervision.

The significant features in the performance of the foundation contract—a joint venture of the Massman Construction Co. and the Kansas City Bridge Co., could be shown by describing the construction of any one of the six large caisson piers which constitute the main foundations of the crossing. However, the article deals specifically with the problems encountered in the sinking and completion of the two mid-river piers.

At the location of these piers, the pivot piers for the twin swing spans, the river channel is 80 ft deep. Below that depth fluid mud is encountered to a depth of 20 ft on top of any material which can give support to the caissons. Here the river necks down to a width approximately 25 percent of that immediately above and below. Therefore the fastest flow of the river occurs at the crossing site, on both the flood and the ebb tides, and practically throughout the full 80-ft depth of the channel. Even with the combined experience and know-how of the two companies, and a few more-or-less original tricks, there was no guarantee of success, mainly because of the gigantic proportions of the operations, the depth of the channel, and the swiftness of the tidal flows in two directions. The magnitude of the work in the caissons is indicated by the fact that the 3,700 tons of structural steel in the six main caissons approximately equals the weight of the structural steel in the superstructure.

On previous bridge foundation jobs, we designed our own caissons. Usually a caisson is considered as a temporary structure, somewhat in the nature of a cofferdam, to aid the sinking and construction of a pier to adequate foundation bearing. Generally the actual type and design of the caissons are left to the contractor, and the designing engineers merely pass on the over-all merits of the caisson as a tool to facilitate the construction of the bridge pier to plan and grade. In this case the consulting engineers not only designed but completely detailed the structural steel caisson to be used for the job.

In sinking and placing bridge piers in a river channel, we have used two general methods. One requires the construction of an artificial sand island at the location of the pier. The other employs a floating caisson. At the York River Bridge site the extreme depth of the water made the use of temporary sand islands impracticable. The consulting engineers had already made the decision to use a floating-type caisson high enough to be landed on the river bottom in water 115 ft deep.

The low bearing values of the foundation material required the use of a light-weight, hollow, rigid, pier base. A watertight shell was also needed since the caisson might be supported by flotation only until its base reached a depth of 115 ft below the river surface. Hence the caisson had to be designed to withstand full hydrostatic pressure at that depth. The outer shell of the all-welded structural steel caisson, which for the pivot pier was 52 x 68 ft (as shown in Fig. 2), was designed to withstand a head of 23 ft before being backed up by seasoned reinforced concrete. When backed up with a 4-ft wall of concrete it would withstand 43 ft of hydrostatic head before the 3-ft concrete cross walls were in place. Dredge wells, 12 ft in diameter, constructed of steel plate, extend the full height of the caisson, and an additional 48 ft through the cofferdam. The addition of the 48-ft-high cofferdam on top of the caisson was necessary so that the structure as a whole would extend 8 ft above the water surface when the caisson was sunk to its final elevation—in the case of pivot pier 18, 150 ft below the water level.

Caissons Fully Fabricated Before Launching

The designing engineers gave the contractors the choice of fabricating and launching the caissons in parts and then building them up in 9-ft increments as sinking progressed, or of fabricating and launching them full height. We chose the latter method, primarily because the Newport News Shipbuilding & Drydock Co. offered excellent facilities for complete fabrication, and because the 60-mile channel from the shipyard to the job site was deep enough so that the completed caissons could be towed to the job.

In the discussion pro and con for each of the alternative methods, it appeared that the advantages of the increment method were that the

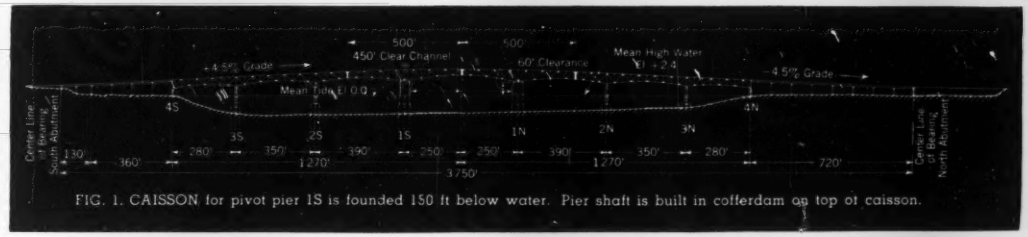


FIG. 1. CAISSON for pivot pier 1S is founded 150 ft below water. Pier shaft is built in cofferdam on top of caisson.

sunk to 150-ft depth in swift-flowing tidal water

original draft would be less; higher concrete lifts could be poured; placing of concrete over the side of the caissons would be easier; exposure to squalls would be less risky; and there would be more opportunity to revise our technique in handling the caissons as the work progressed. The advantages of the full-height method appeared to be a saving in time; a saving in space, desirable because the area available for a parts-fabrication yard at the site was limited; the pouring of higher lifts, made possible by the use of airtight caps on the dredging wells; and finally, the price proposed by the Newport News Shipbuilding & Drydock Co. for fabricating the caissons to full height and their delivery to the site, which was comparable to our estimated cost for assembling and launching them on the site.

Positioned in Pipe-Pile Docks

Our greatest concern was to determine a safe manner of anchoring the caissons in proper position in the deep, swift-running water until their cutting edges had penetrated the river bed sufficiently to assure stability. A study of the winds, currents and tides indicated that normal flows of about 3 mph from either upstream or downstream could be expected with maximum currents of double this normal speed; and that sudden squalls and

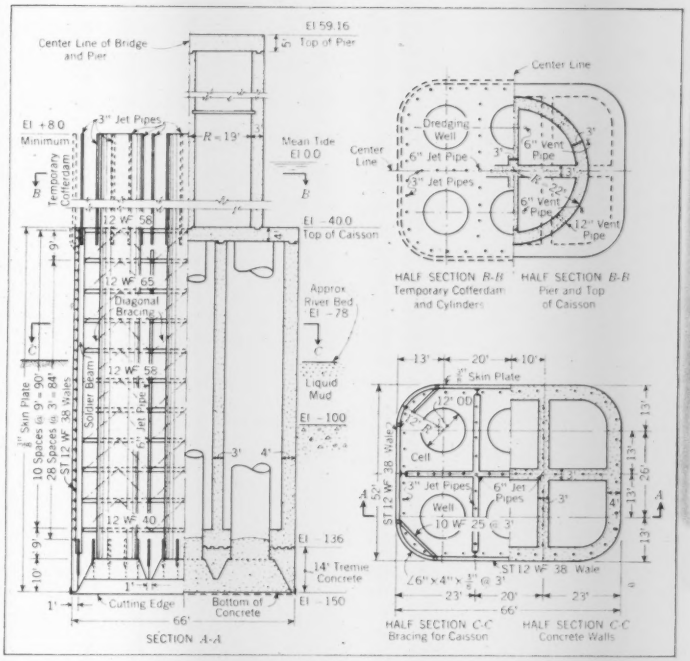
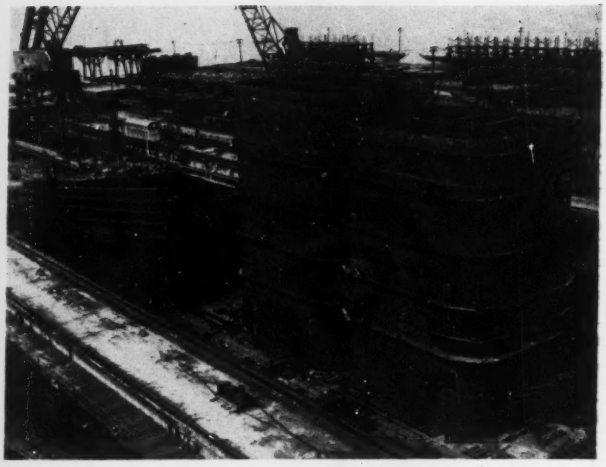


FIG. 2. Structural steel shells for six caissons were floated into position and sunk to bearing 70 ft into river bed as concrete walls were poured.

BRIDGE-PIER caissons are seen in various stages of construction in view from Yorktown side. Circular wooden form near center of river is for pier shaft for pivot pier 1N (Fig. 1). Form extends up out of cofferdam, which rests on top of caisson. Ferry operating from slip in foreground will be superseded by bridge.



PIVOT-PIER caisson shells were completely fabricated and welded in dry dock of Newport News Shipbuilding & Dry Dock Co. alongside of oil tanker. Tanker and caissons were launched on same day.

occasional winds of hurricane velocity could be anticipated. Since one or more caissons would be in floating condition for a period of over a year, our concern for their safety was real.

The contract required that each caisson be held by not less than eight anchors, four attached near the water line and four fastened to the bottom corners. It was determined that, near the bottom in 80 ft of water, a fast current could exert a pressure of 300 kips, which would have to be resisted by anchors. Also, a wind against the freeboard part of the caisson could exert an additional load of 15 psf in the same direction. Such loads would demand very heavy anchors, and heavy rigging and take-up tackle. Anchors sunk into the 20-ft layer of mud 100 ft below the water surface would require cable leads 600 to 700 ft long. Such leads, when fanned out across the river, would be hazardous to our own operations as well as to vessels. Anchors in the bottom mud could be expected to drag, which would make it very difficult to land the caisson within inches of the exact location by transit from shore points 1,000 to 1,200 ft away.

Instead we visualized a fixed structure in the river with sufficient rigidity to maintain the caisson in proper position against the loads and impacts of rough water and storms. Such a temporary dock proved comparatively cheap and economical. Each dock consisted of four four-legged steel-pipe towers 20 ft square and 112 ft high, weighing 45 tons, one at the center of each face of the caisson. The four legs, of 14-in. (O.D.) seamless tubing, were braced in all four faces of the tower with 8-in. and 10-in. standard black pipe welded in place. Pipe made a structure of maximum strength and minimum weight.

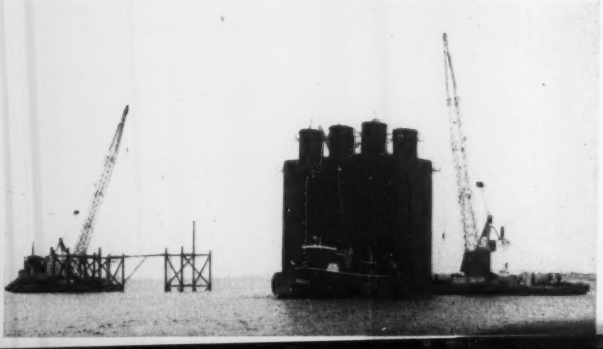
More important than light weight, however, was the round shape of the members. An experience several years previously under less severe conditions had shown that rectangular shaped sections of considerable unbraced length, when submerged in a current, will vibrate and eventually go to pieces. Each tower was set in position by two floating cranes, which between them could handle the 45-ton load.

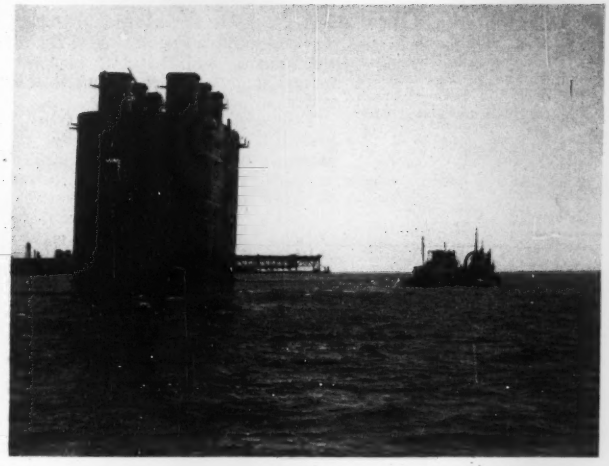
In each dock installation, the upstream tower was placed first, accurately positioned from shore by triangulation, and spudded to the river bottom with $10^{3}/_{4}$-in. (OD) pipe piles 150 ft long, driven completely through the tower legs. When driven, the spud piles were bolted to the top ends of the tower legs. Next, the two side towers were spotted in position by measurements from the first tower and similarly spudded to the bottom. The three towers were then connected together by a fabricated-steel yoke, which received the floating caisson at a time when tide and wind conditions were favorable. The caisson was immediately tied to prevent it from floating out with a change in current or wind. Finally, the fourth tower was installed at the downstream end of the caisson and the yoke attached to it to completely fence in the caisson and restrain it against movement in any direction.

The towers were set to allow a 9-in. clearance between rubbing strips on the towers and the sides of the caisson. By lowering shims between the

MOORING DOCK consisted of four four-legged towers fabricated of tubing and pipe. Bottom section of one tower is shown. A pipe pile, threaded and driven through each leg, spudded tower to river bottom. Dock towers were set to exact location by triangulation to insure that caisson would be sunk accurately.

DOCK CONSISTING of three pipe towers and connecting yoke is in place at left —ready to receive caisson through open downstream end. When caisson was placed in dock, fourth tower was installed to completely fence it in.





SIXTY-MILE TOWING TRIP from drydock to bridge site took 60 hours. About 800 cu yd of concrete was previously placed in cutting edge of each caisson to make it float upright and draw 34 ft of water.

dock and the caisson, the latter was centered within an inch of exact position when the time came to land the cutting edge of the caisson on the firm river bed.

The steel yoke fastened to the tops of the four towers forced all of them to resist movement of the caisson in any direction. At the first two piers, and in anticipation of a storm, we placed two ship anchors upstream and two downstream, with leads hanging slack but arranged so that they could be quickly drawn tight. When the sinking of the first mid-river caisson had proved that the temporary docks were capable of restraining their loads unaided, anchors were omitted on the remaining four docks.

Towers and yokes were fabricated for three docks and each set was used at two locations. The dock installation served also as a temporary platform for construction equipment and shelter houses, and provided mooring facilities for all floating equipment needed during the sinking operations. Survey control points were established on the docks, which were stable enough to make it unnecessary to rely on the triangulation system, which required instrument shots of 4,000 ft.

Bottom Scouring Feared

Every contractor engaged in founding piers in stream beds where currents are present, has experienced the effects of scour around his structure. Instances are known where the lowering into a stream of an object conflicting with the normal flow, has resulted in a turbulence that scoured the river bottom to a depth of 50 ft over a comparatively large area. In this case it was believed that severe scouring in the caisson working area would result in a dock failure—a disagreeable prospect viewed from any angle. However, the continuous 20-ft layer of fluid mud on the river bottom seemed to indicate that the current never swept the bottom of the channel clean at this location. It seemed logical that if the current did move considerable mud from the dock area during its flow in one direction, it would sweep this material back again when it reversed itself on the next tide.

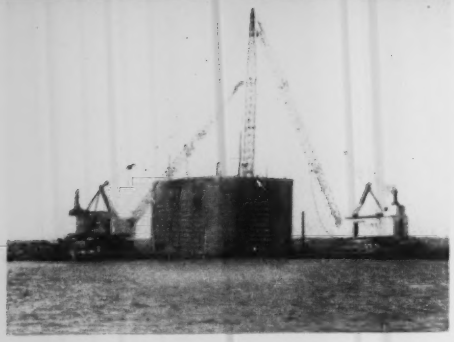
This line of reasoning gave encouragement to the idea of landing the caissons by using pipe docks. The advantages of the method were too attractive to turn down, and we felt the proverbial inclination of contractors to take a chance. It proved to be a good hunch. The job records show that there was no measurable scour of either mud or firm material at any of the caisson sites. All the caissons have been landed safely without any hazardous experiences.

CAISSON AT LEFT has been secured in mooring dock ready for start of sinking operation. Caisson at right has been sunk completely below river surface, and lower part of follower cofferdam has entered water.

Transit-Mixed Concrete for Caissons

The procedure of hoisting the concrete over the top of the tall caissons and lowering it about 100 ft down through a maze of internal forms and bracing was a complicated one. Concrete materials were batched in a plant set up about 500 ft from the river bank on the Yorktown side. Transit-mix trucks received the material from the batching plant and made the short run to the loading dock, constructed on piling, where they discharged it into a 14-cu yd receiving hopper. From the receiving hopper it was transported by two small tugs, each made up to a steel barge capable of carrying four 2-cu yd buckets apiece. The concrete buckets were delivered to a floating revolving crane equipped with a 125-ft boom at each caisson. The crane hoisted the buckets over the top of the caisson and lowered them one at a time into the interior. The maze of bracing allowed the buckets to be lowered in certain areas only, and in these areas clearances amounted to inches.

During periods of rough water, the 125-ft booms on the floating cranes went through such gyrations that it became impossible to thread the bucket down through the bracing until guides were installed. These guides were flared out at the top to receive the bucket and then narrowed down,



FOLLOWER COFFERDAMS were fabricated of ¼-in. steel buckle plates and designed to withstand 45-ft head. Pipe mooring dock has been removed for reuse on another caisson.

so that the bucket dropped down somewhat like an elevator traveling in its shaft. At the lower end of the guides, the contents of the bucket were dumped into a 3-cu yd receiving hopper on a temporary platform. This platform served as a runway for rubber-tired "Georgia buggies." In these one-man pushcarts, workmen distributed the concrete to dumping stations at 10-ft intervals along the pattern of walls being poured. Hoppers and elephant trunks were suspended from the platform at the dumping stations, where a hatch door in the platform permitted cart traffic over the top.

A system of traffic control, complete with a one-way lane for loaded carts and another for empties, was established to coordinate the cart movements on the platform. When a 27-ft lift had been poured, the platform was raised 27 ft and the operation repeated until the concrete reached the top of the 100-ft-high walls.

Steel forms were moved up in 9-ft increments, permitting pours from 3 to 9 ft high, according to the hydrostatic head on the caisson shell and the strength of the previously placed concrete. All cross bracing, as well as the jetting wells, were encased in the cross walls. Reinforcing steel was placed in the conventional manner but the working space in the forms was so confined that the workmen who placed, vibrated and finished the concrete had to be of small stature.

After each pour, the 25 or 30 sets of hoppers and chutes and the other concreting equipment had to be washed down and the water and debris from the operation lifted out over the top of the caisson. Each increment of weight directly affected the caisson's draft and dictated the amount of green concrete that could be placed in each pour. The completed caisson is topped off with a 4-ft slab on which the pier shaft is set, but the shaft cannot be started until the caisson base is landed and sealed at plan depth.

Temporary Cofferdam for Pier Shaft

When sunk to plan elevation, the tops of the caissons are 40 ft below water level (Fig. 2). For bringing up the pier-shaft work in the dry, a temporary steel follower cofferdam was built on top of each caisson. This feature of the sinking operation represents a change which the contractors decided to make in the original scheme suggested by the designing engineers. The cofferdam had to be watertight; it had to extend above wave action to a height of 48 ft above the caisson; and it had to be built before the caisson sank below the water surface.

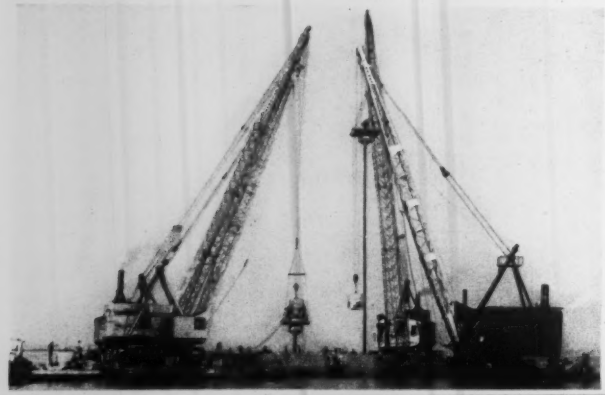
The design engineers' plan suggested a cofferdam constructed of standard interlocking steel sheetpiles attached to the top of the caisson with a watertight joint and internally braced for a 45-ft head. Instead, we decided to construct the cofferdam shell of steel sag-plate panels with watertight bolted joints, using regular garden hose for gaskets. This change was made to insure that no water would leak into the empty caisson before it was ready to carry this added load. Job borings indicated that the top of the caisson could be under water 5 or 10 ft and still be floating before it reached firm bearing at about −115.0. Leakage through the cofferdam, accumulating in the caisson, would interfere with operations. We certainly did not want to take the chance of having to pump several thousand tons of water out of the caisson while it was still floating and unsealed. Therefore the more expensive type of cofferdam construction was adopted.

In the actual sinking operation, we found that the layer of fluid mud did not scour out and did give considerable support to the caisson as soon as the cutting edge entered it. The caissons were ready to take considerable weight even while their tops — and the bottom of the cofferdams — were 10 ft above the river surface. Thus the sheetpile type of cofferdam suggested by the designing engineers would have served the purpose.

A contractor who has completed a foundation job of any magnitude rarely has the satisfaction of being able to say that he did it exactly right. But in this case, with the work nearly done, we know of only a few small changes that we would make in the construction of the piers of the George P. Coleman Memorial Bridge were we to do the job over again. Seldom does a contractor find, on completion of such a big project, that the finished structure conforms so closely with the bidding plans in nearly every detail. This result, made possible by the careful planning and preliminary study of the engineers, make the project a monument to the skill of the engineering profession.

(This article is based on the paper presented by Mr. Newell before the joint session of the Construction and Structural Divisions presided over by R. N. Bergendoff, M. ASCE, at the ASCE Louisville Convention.)

CAISSON has been landed at about −150 ft, and 8 ft of freeboard remains on follower cofferdam. Seal concrete is being placed with two 160-ft tremie pipes working through dredging wells. Tremie on right is being withdrawn for transfer to another dredging well in caisson.



ENGINEERS' NOTEBOOK

Complicated hydraulic structures analyzed by Hazen-Williams formula

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FLOW of water under pressure in a pipeline is usually determined by the Hazen-Williams formula. This article will show how that equation can be transposed to the form, $h = kRQ^{1.85}$, for friction losses. Velocity head or losses due to velocity head will be developed in terms of the general equation. It will be shown how all the elements of any branch of a pipe system can be quickly obtained. The summation of the coefficients of these elements will give the desired branch-line equation. It will be shown how a change from one C_w to another can be made by applying a dimensionless factor, k. These equations will be found useful in analyzing the most complicated of hydraulic structures and devices.

The Hazen-Williams equation as generally used gives the head loss, h, per 1,000 ft of one size of pipe for one assumed rate of flow. In the more difficult problems of flow of water in pipe branches, this approach has certain disadvantages. The writer here describes a relatively simple method of writing equations for any conditions existing in a branch of a pipe system.

The usual equations can be changed to terms of h and Q to develop the resistance factors, which can be adjusted to any roughness condition. We should be able to express friction loss or velocity head loss in these terms.

The equations will be developed to an abstract form, as follows:

$$h = kR_aQ^x = R_bQ^x \quad (1)$$

Where h = head loss, in feet
k = a dimensionless factor dependent on friction or the number of velocity heads involved
R_a = a resistance factor dependent on length and size of the pipeline and one basic friction factor, a, or one velocity head
R_b = product of kR_a
Q = rate of flow in cubic feet per second
x = an exponent, which for friction losses will be assumed to equal 1.85. For velocity heads and velocity head losses, $x = 2.0$.

The equation in its abstract form looks formidable. However, by reference to Tables I and II, the values of k and R_a per 1,000 ft will be found, and R_b can be computed for any length of line. That is all there is to writing a pipeline equation.

Friction Losses

The Hazen-Williams equation is given as

$$v = 1.328\ C_w r^{0.63} s^{0.54} \quad (2)$$

When a branch of a pipe system involves several sizes of pipe, this equation must be applied to each size. In most problems it is a question of what the head loss is for a given rate of flow or vice versa. The equation can be rewritten in terms of h and Q if the following substitutions are made: $v = Q/A$; $r = d/4$; $s = h/L$. Substituting in Eq. 2 and transposing

$$h/1{,}000 \text{ ft} = (0.942/d^{4.87})Q^{1.85} \quad (3)$$

where $C_w = 100$, and d is in feet, for flow in cubic feet per second.

Subtracting Eq. 3 from Eq. 1 and noting that $x = 1.85$, $a = b = 100$,

TABLE I. BASIC RESISTANCE FACTORS R_a

Where L = 1,000 ft, C_w = 100, and flow is in cfs

I.D. In.	Friction, R_{100}	One Velocity Head, R_v	Area in Sq Ft
2	5885.0	32.26	0.0218
4	199.5	2.045	0.0873
6	27.62	0.4028	0.1964
8	6.812	0.1276	0.3492
10	2.291	0.05220	0.5456
12	0.9420	0.02517	0.7854
14	0.4470	0.01358	1.0682
15	0.3181	0.01031	1.2272
16	0.2349	0.00796	1.3968
18	0.1308	0.004975	1.7676
20	0.07819	0.003268	2.1817
21	0.06179	0.002694	2.4053
22	0.04932	0.002173	2.6399
24	0.03225	0.001573	3.1416
27	0.01815	0.0009835	3.9761
30	0.01089	0.0006455	4.9088
32	0.007930	0.0004980	5.5865
33	0.006835	0.0004416	5.9396
36	0.004485	0.0003108	7.0686
39	0.003038	0.0002258	8.2958
40	0.002691	0.0002046	8.7249
42	0.002117	0.0001678	9.6212
45	0.001507	0.0001271	11.0447
48	0.001102	0.00009850	12.5664
51	0.0008190	0.00007722	14.1863
54	0.0006240	0.00006140	15.9044
57	0.0004770	0.00004936	17.7206
60	0.0003751	0.00004028	19.6350
63	0.0002943	0.00003311	21.6476
66	0.0002342	0.00002741	23.7584
69	0.0001884	0.00002309	25.9673
72	0.0001530	0.00001942	28.2744
75	0.0001256	0.00001651	30.6797
78	0.0001043	0.00001414	33.1832
81	0.00008600	0.00001210	35.7848
84	0.00007250	0.00001049	38.4846
90	0.00005190	0.00000797	44.1788
96	0.00003769	0.00000642	50.2656
108	0.00002122	0.000003843	63.6174
120	0.00001271	0.000002517	78.5400

Gpm $R_{100}/80{,}600$ Mgd 2.242 R_{100} | $R_v/201{,}600$ 2.393 R_v

and $k = 1$, the resistance due to friction equals

$$kR_a = R_b = R_{100} = (0.942/d^{4.87}) \text{ per } 1{,}000 \text{ ft} \quad . . (4)$$

This is the basic equation from which the resistance factors R_{100} were computed. See Table I.

Equation 3 uses one roughness condition only. To change this to any C_w, we need only to place 100 in the numerator and the required C_w in the denominator, both to the 1.85 power. It will be observed from Eq. 1 that this will give

$$k = (100/C_w)^{1.85} = R_w/R_a \quad . (5)$$

$$\text{or } C_w = 100/k^{0.54} \quad . . . . . (6)$$

$$\text{and } h_f = kR_{100}Q^{1.85} = R_wQ^{1.85} \quad . (7)$$

It should be noted that we are not limited to R_{100} as a base. Assume a coefficient for a pipeline where R_w is based on $C_w = 110$, which we wish to change to $C_w = 130$. Under these conditions the new k value will be $(110/130)^{1.85} = 0.734$. Then the new coefficient will be $0.734\ R_{110} = R_{130}$.

Rating curves can be developed as quickly as the equations by using a part of the following data and plotting head loss, h, against Q:

Friction Head

Q	$Q^{1.85}$	h
0.288	0.1	$0.1\ R_w$
1	1.0	$1.0\ R_w$
3.47	10	$10\ R_w$
12.0	100	$100\ R_w$
41.7	1,000	$1{,}000\ R_w$
144.5	10,000	$10{,}000\ R_w$

TABLE II. BASIC RESISTANCE FACTORS, R_{100}, FOR STANDARD SCREW PIPE AND MULTIPLYING FACTORS

When L = 100 ft, C_w = 100, and flow is in gpm

Trade Size, In.	Actual I.D., In Standard	Resistance R_{100} For gpm*	Actual Area, Sq Ft	One Velocity Head, R_v for gpm†	Table of Multiplication Factors C_w	k‡
					47.5	4.00
					50	3.61
					55	3.03
					60	2.57
0.25	0.364	28.59	0.000723	0.1482	65	2.22
0.375	0.493	6.53	0.001326	0.0440	68.8	2.00
0.50	0.622	2.108	0.002110	0.01737		
					70	1.94
0.75	0.824	0.537	0.003703	0.00564	75	1.71
1.00	1.049	0.1658	0.006002	0.002148	80	1.51
1.25	1.380	0.0437	0.01039	0.000717		
					85	1.35
1.50	1.610	0.02061	0.01414	0.000387	90	1.21
2.00	2.067	0.00611	0.02330	0.0001427	95	1.10
2.50	2.469	0.002574	0.03324	0.0000700		
					100	1.00
3.00	3.068	0.000894	0.0513	0.00002935	105	0.915
3.50	3.548	0.000441	0.0687	0.00001641	110	0.838
4.00	4.026	0.0002383	0.0884	0.00000991		
					115	0.772
5.00	5.047	0.0000794	0.1389	0.00000401	120	0.715
6.00	6.065	0.00003250	0.2005	0.0000001916	130	0.616
8.00	7.981	0.00000853	0.3474	0.0000006370		
					140	0.537
10.00	10.020	0.0000002821	0.5476	0.0000002572	145.4	0.500
12.00	12.000	0.0000001173	0.7854	0.0000001250	150	0.473

* $h_f = kR_{100}Q^{1.85} = R_wQ^{1.85}$ $\quad$ † $h_v = k_vR_vQ^2$ $\quad$ ‡ $k = (100/C_w)^{1.85} = (R_w/R_{100})$

$R_{100} = 0.000\,001173/d^{4.87}$ $\quad$ $R_v = 0.000\,000\,1250/d^4$

Pipe Diameter

It is frequently required to find the diameter of a pipe for a given length, rate of flow Q, and a maximum allowable head loss. The diameter can be found by changing Eq. 7 by replacing R_{100} with $0.942\ L/D^{4.87}$ and transposing to explicit terms of d in feet.

$$d = (k\ 0.942\ L\ Q^{1.85}/h)^{0.2053} \quad . . . (8)$$

Velocity Head Losses

While friction should account for the greater part of the losses in a system of pipelines, there are always problems that involve velocity head or losses due primarily to velocity head. The usual equation for a part of one velocity head is $h_v = k_vV^2/2g$, in which k_v is the part of a velocity head involved. By substituting Q/A for V, the equation is converted to terms of h and Q:

$$h_v = k_vQ^2/A^2 2g = k_v(0.02517/d^4)\ Q^2 = k_vR_vQ^2 \quad . (9)$$

With this equation it is not necessary to compute the velocity for every size of pipe. In problems considering a constant rate of flow, the resistance factors R_v are added or subtracted as the case may require.

Hydraulic problems occasionally involve short lengths of screw pipe where the rate of flow is considered in gallons per minute. Table II gives resistance factors per hundred feet of pipe based on gallons per minute. These data are used in the same manner as the data from Table I. Using these data, not only the designer but those in higher authority can make quick and accurate checks for h, Q, or d. The equations give a much better idea of the operating limits of any hydraulic condition.

Example 1

As an example of the use of this method, assume a trunk line consisting of a 36-in. by 24-in. tee as a

TABLE III. SOLUTION FOR EXAMPLE 1

Item	C_w	k Eq. 5	k_v	R_v Table I	$R_{100}/1000$ Eq. 4 Table I	Length†	R_{100}	K_vR_v or $R_w = kR_{100}$	Equations of Items	Head Loss for 12 cfs in ft§
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
24" entry			2.0	0.001573				0.00315	$h_v = 0.00315Q^2$	0.45
24" pipe	145.4	0.500		0.001573	0.03225	3.000	0.0967	0.0484	$h_f = 0.0484Q^{1.85}$	4.84
24" × 18" reducer			1.1	0.003402*				0.00374	$h_v = 0.00374Q^2$	0.54
18" pipe	110	0.838		0.004975	0.1308	2.000	0.2616	0.2193	$h_f = 0.2193Q^{1.85}$	21.93
18" × 12" reducer			1.1	0.00202*				0.0222	$h_v = 0.0222Q^2$	3.20
12" pipe	68.8	2.000		0.02517	0.942	250	0.2355	0.471	$h_f = 0.471Q^{1.85}$	47.10
							$\Sigma R_{100} = 0.594$	$\Sigma R_w = 0.739$‡	$\Sigma h_v = 0.0291Q^2$	Total 78.06
									$\Sigma h_f = 0.739Q^{1.85}$	

* Differential head.

† Length including reducers.

‡ The over-all $k = 0.739/0.594 = 1.245$ and from Eq. 6, $C_w = 88.8$.

§ These values were carried to 100ths only to illustrate this problem.

Total head loss H_t = the equation of the pipeline = $\Sigma h_f + \Sigma h_v$

starting point; 3,000 ft of 24-in. pipe at C_w = 145.4; a 24×18-in. reducer; 2,000 ft of 18-in. pipe at C_w = 110; an 18×12 reducer, and 250 ft of 12-in. at C_w = 68.8. Assuming one velocity head loss at entry and at the reducers, add 10 percent to the differential head as loss.

What are the equations of the several elements of this line and what is the total drop in the hydraulic grade when Q = 12 cfs? What is the over-all C_w for this line?

Table III tabulates the solution of this problem. Columns 1, 2, 4, and 7 are the given conditions. The values of k in Col. 3 will be found in Table II or can be computed from Eq. 5. The values under Cols. 5 and 6 (R_v and $R_{100}/1{,}000$) are obtained from Table I. The value of the R_v for each reducer is the difference between the velocity heads of the smaller and larger pipe sizes.

Column 9 gives the resistance factors for each of the items listed. Column 10 gives the equations for every considered item in the pipeline as required. Column 11 gives the losses for every item when the flow equals 12 cfs. The total for this flow is 78.5 ft. Following Eq. 5, the over-all k = 739/0.594 = 1.245. Using this value in Eq. 6, C_w = 88.8.

Example 2

As a second example, assume that a 6-in. globe regulator with cross-connection fittings will maintain a uniform hydraulic grade on the discharge side when the internal loss is 10 velocity heads or less. For this problem assume the head on the regulator to be 403 ft (approximately 175 lb). What is the maximum discharge that can be expected?

From Table I, R_v = 0.403 for one velocity head and the 10 R_v = 4.03. Under these conditions the head, 403 = 4.03 Q^2, and Q = 10 cfs maximum.

Constant-factor method aids computation of reservoir sediment

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SEVERAL METHODS have been developed for computing the amount of sediment deposited in a lake or reservoir, including the following:

1. **Area-depth method.** Area of segment times average depth of sediment.
2. **End area-length method.** Average cross-sectional area of sediment times length of segment.
3. **Modified-prismoidal method.** Described in Technical Bulletin No. 524, U.S. Dept. of Agriculture, August 1939.
4. **Contour area-interval method.** For each survey, this method requires a detailed hydrographic map of the entire reservoir to obtain contours of existing sediment.
5. **Radial sounding method.** Sounding boat is attached to a radial cable, a method sometimes used where unusual deposition requires a detailed survey.
6. **Rectangular spotting method.** For relatively large, flat areas, uniformly spaced soundings are made in a grid pattern and calculations for sediment are made by the area-depth method.
7. **Effective-length or constant-factor method.** A modification of the end area-length method, which is the subject of this article.

Personnel of the Reports Branch, Fort Worth District, Corps of Engineers, collaborated during 1948 in developing a method for computing the volume of sediment in reservoirs where cross-sectional areas are measured at representative locations called ranges. Portions of a reservoir bounded by one or more ranges and the contour at the elevation of the crest of the dam are considered as segments for convenient determination of the sediment volume. Parts of a segment situated between contour planes will be referred to as subsegments. The effective length of a segment (or subsegment) is defined as the original segmental (or subsegmental) volume divided by half the sum of the corresponding cross-sectional areas at the principal ranges bounding the segment (or subsegment).

The initial storage capacity of a reservoir should be obtained from an elevation-area curve determined from the most reliable topographic maps available. If a suitable contour map is not available, fairly accurate contours can be developed from a large number of cross sections taken before closure of the dam or spud-sounded at a later date to spot the various contour positions.

Constant-Factor Formula

The following four steps are required in developing the effective-length or constant-factor method:

$$L = \frac{V_0}{\frac{1}{2}(A_0' + A_0'')} \quad \ldots\ldots(1)$$

$$V_s = \frac{(A_s' + A_s'')}{2} L \quad \ldots\ldots(2)$$

$$V_s = \frac{V_0}{(A_0' + A_0'')} (A_s' + A_s'') \quad \ldots(3)$$

$$\text{Let } f = \frac{V_0}{A_0' + A_0''}$$

$$V_s = f(A_s' + A_s'') \quad \ldots\ldots(4)$$

in which

L = effective length
V_0 = original volume
V_s = volume of sediment

A_0' = original area of downstream cross section
A_0'' = original area of upstream cross section or sections
A_s', A_s'' = respective sediment cross-section areas
f = constant factor for subsegment

The first equation is based on the definition of effective length for an incremental volume, namely, the length by which the mean end area is multiplied to obtain the original volume. Equation 2 indicates that it is possible to compute the volume of sediment when the effective length of subsegment is known. In Eq. 3 the volume of silt is shown to be that portion of the original volume expressed by the ratio of the total cross-sectional area of sediment to the corresponding original cross-sectional area. Substituting the factor f for the ratio $\frac{V_0}{(A_0' + A_0'')}$, Eq. 4 becomes the formula for computing sediment volumes. Since this factor remains unchanged for each subsegment unit, the procedure was designated as the constant-factor method. Once determined for each subsegment, this factor may be applied in computations for all sedimentation surveys.

Typical Form of Computations

To illustrate the simplicity of the constant-factor method, a sample sheet (Table I) of typical sediment computations is given. Space for computing future sediment deposits can be provided by adding three columns for successive surveys. The increments of sediment volumes are totaled horizontally to obtain the total amount of sediment in each contour interval or partial interval. This table shows how the Tulsa Office of the Corps of Engineers applied the new method in computing the amount of sedimentation in Lake Texoma (the reservoir behind Dennison Dam) for the 1948 survey. Instead of sediment volumes, the remaining water capacity was calculated by using the constant factors listed in Col. 6. The difference between the original volume (Col. 2) and the water volume (Col. 10) gives the quantity of sediment (Col. 11).

Results by Different Methods Compared

The Tulsa District utilized the accepted elevation-area curves to compute the original storage capacity of Lake Texoma (Survey of 1939–1940). An attempt was made to compute the existing storage capacity for the sedimentation survey of December 1948 using the modified-prismoidal method. The ranges across Texoma Lake had been laid out at such unsatisfactory angles that the results showed inconsistencies which could not be reconciled or accepted.

Similar studies indicate that sediment volumes calculated by this method and others in common use give quantities of from 5 to 30 percent more or less than those obtained by the new method. The constant-factor method compensates for the channel curvature and irregularities in the valley section between ranges, which are usually placed at the narrowest sections.

Principal Advantages

The principal advantages of the proposed method are:

Uniformity. Uniformly accurate results are assured, whereas old methods in common use require the exercise of considerable personal judgment.

Accuracy. The accuracy is consistently greater than that obtained by other methods in common use, with the possible exception of the expensive contour method.

Economy. Table I illustrates the simplicity of the constant-factor computations, which can be executed with one setting of the slide rule. The greatest economy will be realized when computing results for a number of surveys.

Adaptability. An important feature is the flexibility permitted in laying out sedimentation ranges at any angle with the channel or with each other, the use of a number of bounding cross-sections, the selection of different sets of ranges at different elevations, and even the possibility of changing the range layout if the dam is raised.

Practicability. Among the practical advantages is the fact that, once the original volume of the reservoir segments has been determined by any method, the computed volume of a silted-up segment will equal the original volume.

(The paper here abstracted was originally prepared by Mr. Burrell for presentation at the ASCE Houston Convention before the Hydraulics Division, presided over by George R. Schneider.)

Table I. Typical Sheet for Computing Sediment by "Constant-Factor" Method for Lake Texoma, Reservoir behind Dennison Dam, on Red River, Texas and Oklahoma; dam closed March 1942

(Segment between Ranges 24 and 26)

		End Areas, Original (1939–1940) Cross Sections, Sq Ft				End Areas, 1948 Cross Sections, Sq Ft				
El., Ft M.S.L. (1)	Orig. Volume Acre-ft (2)	Range No. 24 (3)	Range No. 26 (4)	Col. 3 plus Col. 4 (5)	Col. 2 Divided by Col. 5 (6)	Range No. 24 (7)	Range No. 26 (8)	Col. 7 plus Col. 8 (9)	Water Vol. Col. 6 times Col. 9, Acre-ft (10)	Sediment Col. 2 minus Col. 10, Acre-ft (11)
530										
540	3,550	6,875	229	7,104	0.49972	347	0	347	173	3,377
550	7,955	31,944	3,890	35,834	0.22200	22,639	1,526	24,165	5,365	2,590
560	26,565	97,181	7,857	105,038	0.25291	93,708	7,246	100,954	25,532	1,033
570	47,535	102,583	19,137	121,720	0.39053	101,958	18,526	120,484	47,053	482
580	53,800	103,903	27,475	131,378	0.40951	103,625	27,399	131,024	53,656	144
590	61,235	106,292	29,297	135,589	0.45162	105,528	28,763	134,291	60,649	586
600	70,435	112,833	42,577	155,410	0.45322	112,139	43,645	155,784	70,605	−170
610	79,010	117,653	90,094	207,747	0.38032	116,958	89,408	206,366	78,485	525
617	58,517	85,167	71,822	156,989	0.37275	84,681	71,898	156,579	58,365	152
620	25,424	37,297	32,047	69,344	0.36664	37,228	32,047	69,275	25,399	25
630	86,220	126,319	109,221	235,540	0.36605	126,111	108,992	235,103	86,059	161
640	88,285	128,444	112,068	240,512	0.36707	128,167	112,068	240,235	88,183	102
Total	608,531	1,056,491	545,714			1,033,089	541,518		599,524	9,007

THE READERS WRITE

Steinman's Method of Solving Higher Degree Equations Compared with Newton's

TO THE EDITOR: The invitation extended by D. B. Steinman in his article, "Simple Formula Solves All Higher Degree Equations" (February 1951 issue, p. 44) prompts the following comments.

Consider two choices of procedure for evaluating the root of a polynomial function. One is to apply Newton's tangent formula to the polynomial to evaluate the root directly. The other is to "reverse" the polynomial and apply Newton's tangent formula to evaluate the inverse of the root. Steinman's Eq. 2 can be rearranged to show that it is identical with this latter procedure.

A comparison of the procedures can be exemplified by applying the inverse Newton procedure to Examples 1–6 and 8. The results match Steinman's. In comparison, the results obtained in Example 7 by Steinman after inversion can be matched by applying Newton's method directly. In effect, Steinman has proposed the use of inversion to supplement Newton's formula, for cases where this speeds convergence.

Unfortunately, in the general case there appears to be *no basis for making the better choice* between the use of Newton's tangent formula directly or supplemented by inversion, *other than to try both procedures* for the more rapid convergence. That fractional roots do not determine the choice is easily seen by multiplying all the roots of any fractional-root polynomial by a power of 10 to increase the root beyond unity. The computations for the root and the amplified root are identical except for the decimal point.

In fact, there are many polynomials which are better "linearized" somewhere between the extremes of the Newtonian and Steinman procedures. Steinman's Eq. 6 for the extraction of roots is a case of linearization "halfway" between the two.

It is suggested that consideration be given to use of Newton's formula with the second derivative correction introduced:

$$x_1 = x_0 - \frac{f(x_0)}{f'(x_0) - \dfrac{f(x_0)\, f''(x_0)}{2f'(x_0)}} \qquad (A)$$

Equation A may suit the general case better than the double-choice procedure. Moreover it is general, being applicable also to transcendental $f(x)$. To obtain the nth root of N, Eq. A reduces identically to Steinman's Eq. 6:

$$x_1 = x_0 + x_0 \frac{2(N - x_0^n)}{n(N + x_0^n) - (N - x_0^n)} \qquad (6')$$

As an example showing the application of Eq. A, the following evaluation of the root of Steinman's Example 7 is given:

$x_0 = \frac{1}{6}$)

4	− 18	+ 20	− 3
	+ 0.6667	− 2.8889	+ 2.851852
4	− 17.3333	+ 17.1111	− 0.148148

$= f\left(\frac{1}{6}\right)$

$\frac{1}{6}$)

12	−36	+20
	+ 2	− 5.6667
12	−34	+14.3333

$= f'\left(\frac{1}{6}\right)$

$\frac{1}{6}$)

24	−36	
	+ 4	
24	−32	

$= f''\left(\frac{1}{6}\right)$

$$+0.1666667 - \frac{-0.148148}{+14.3333 - \dfrac{-0.1481\,(-32)}{2 \times 14.33}}$$

$$= 0.1771232 = x_1$$

$$(0.1771243+)$$

One trial only is needed, using the same trial root as Steinman, whose method gave $x_1 = 0.1770$.

THOMAS JEFFERSON OGBURN III,
Richmond, Va. Assoc. M. ASCE

EDITOR'S NOTE: *Mr. Ogburn's letter has been chosen for publication as representative of the various discussions of Dr. Steinman's article that have been received. Dr. Steinman's closure, which appears below, takes into account his correspondence with all these discussers.*

Procedures Correlated

TO THE EDITOR: The interest aroused by the writer's article has been very gratifying. The correspondence and discussions received indicate also that the article has stimulated original investigations by others.

The writer did not claim that his formula solution (CIVIL ENGINEERING, February 1951, pp. 44–45) is always the best for all equations. No method is. Special procedures may be advantageous in special cases. The question is whether any other single method *of equal generality and simplicity* will give as uniformly good results in all cases.

Computers who are accustomed to specific solution procedures will naturally prefer the methods with which they are most familiar. Many readers, however, welcome a solution that does not involve the notation of calculus and the operations of differentiation, especially when this solution yields more accurate results in the cases usually occurring in practice.

In all the numerical examples in the original article, the formula solution yields better results than Newton's method, provided the given equation is reversed where indicated (as in Example 7). By a further extension of the formula solution, still greater generality and accuracy can be secured, unequaled by any previously known method.

The formula can be easily remembered and applied. For example, consider the cubic equation

$$mx^3 = ax^2 + bx + c$$

Then, for any trial root x_0, the formula is simply

$$\frac{x_1}{x_0} = \frac{a\,x_0^2 + 2\,bx_0 + 3c}{m\,x_0^3 + 0\,x_0^2) + bx_0 + 2c}$$

In the general case, the coefficients in the numerator are:

$$a, 2b, 3c, 4d, \ldots$$

and those in the denominator are:

$$m, 0a, 1b, 2c, 3d, \ldots$$

That is all that needs to be remembered. The substitution of x_0 is conveniently done by synthetic division.

For a comparison and correlation of the several procedures, including the writer's algorithm (CIVIL ENGINEERING, June 1950, p. 41, and September 1950, p. 48) and his extension of the formula method, let us solve the equation,

$$2x^3 = 9x^2 + 10x - 12$$

Solution by the writer's formula:

$x_0 = 5$	9	20	−36
		45	325
	9	65	289
5	2	0	10	−24
		10	50	300
	2	10	60	276

$$x_1 = \frac{289}{276}(5) = 5.236$$

(Second trial:

$$x_0 = 5.236,\ x_1 = 5.2360679775)$$

Newton's method
(using synthetic division):

$$x_0 = 5 \;\Big|\; \begin{array}{rrrr} 2 & -9 & -10 & +12 \\ & 10 & 5 & -25 \\ \hline 5 & 2 & 1 & -5 \\ & & 10 & 55 \\ \hline 5 & 2 & 11 & 50 \\ & & 10 & \\ \hline & 2 & 21 & \end{array} \quad \begin{array}{l} -13 = R_0\ (= y_0) \\ \\ = R_1\ (= y_0') \\ \\ = R_2 \left(= \frac{1}{2} y_0''\right) \\ \\ = R_3 \left(= \frac{1}{6} y_0'''\right) \end{array}$$

$$x_1 = x_0 - \frac{R_0}{R_1} = 5 - \frac{-13}{50} = 5.26$$

(Second trial: $x_0 = 5.26$, $x_1 = 5.236$)

Newton's tangent method with second derivative correction:

$$x_1 = x_0 - \frac{1}{\frac{R_1}{R_0} - \frac{R_2}{R_1}} = 5 - \frac{1}{\frac{50}{-13} - \frac{21}{50}}$$

$$= 5.2344 \text{ (vs. } 5.2361)$$

For third and higher derivative corrections, a convenient formula expression for x_1 is not practical. Fortunately, the writer's algorithm, applied to the *reduced* equation, gives successive approximations which are *identical* with the solutions corresponding to the successive derivative corrections.

Solution by the writer's algorithm:

By the synthetic division given above, using the successive remainders R_0, R_1, R_2, R_3, as the new coefficients, the *reduced* equation is

$$13 z^3 = 50 z^2 + 21 z + 2$$

corresponding to $x = 5 + 1/z$. To eliminate $m = 13$, multiply the root by 13, obtaining:

$$u^3 = 50 u^2 + 273 u + 338$$

$$\left(\text{representing } u = 13 z,\ x = \frac{1}{z} = \frac{13}{u} = \frac{13 r_1}{r_2}\right).$$

	50	2500	138650	7631900
		273	13650	757029
			338	16950
r = 1	50	2773	152638	8405879
Δx =	0.26	0.2344	0.23617	0.23606
x_1 =	**5.26**	**5.2344**	**5.23617**	**5.23606**
	$= A_1$	$= A_2$	$= A_3$	$= A_4$

(A_1 = solution by Newton's method; A_2, A_3, A_4, etc., = solutions with second, third, fourth, etc., derivative corrections.)

Note that the simple, direct solution by the writer's formula ($x_1 = 5.236$) gives a quicker and better result than A_2 (the second derivative correction).

Finally, compare the following with all the preceding solutions.

Application of the writer's formula to the reduced equation:

$$13 z^3 = 50 z^2 + 21 z + 2. \quad \left(x = 5 + \frac{1}{z}\right)$$

z_0 = 4	50	42	6		4	13	0	21	4
		200	968				52	208	916
	50	242	**974**			13	52	229	**920**

$$x_1 = 5 + \frac{920}{974(4)} = 5.2361$$

This is a quicker and better result than A_3 (the third derivative correction). All three roots (5.2361, 0.76393, and -1.500000) are advantageously solved by this method, without exception or modification.

It is hoped that these two methods, the algorithm and the formula solution, will add to the resources of engineers and mathematicians.

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Design of Steel Column Base with Tension in Anchor Bolts

TO THE EDITOR: It is believed that the design of a steel column base for the case that a moment causes tension in the anchor bolts can be solved in a much shorter and more direct way than that presented in Stephen W. Waterman's article, "Base Plates for Fixed-End Columns Should Be Designed to Resist Uplift," in the April issue. This problem, being identical with the design of a concrete section with tensile reinforcing only, and subjected to combined bending and axial load, is treated in more or less detail in most textbooks on reinforced concrete.

An especially convenient method is described in the *Reinforced Concrete Design Handbook* of the American Concrete Institute (pp. 8, 11, 12), where it is shown that the required size of the anchor bolts can be easily found without the detour of first assuming their area and then investigating the stresses.

Mr. Waterman's three charts for finding the location of the neutral axis may be of some value where an existing building has to be checked for new loading conditions or for some problems in the design of base-plate details for which it is imperative to know the stress distribution under the base plate. However, his representation of the relations between the variables would have been more concise had he measured the eccentricity with respect to the axis of the anchor bolts and replaced the over-all depth a in the ratios q, r, and k with the effective depth d. If this is done, a single chart is sufficient to cover all edge distances of the anchor bolts.

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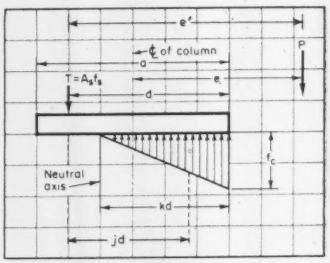
Base-Plate Design Carried One Step Further

TO THE EDITOR: The writer submits the following comment on "Base Plates for Fixed-End Columns," by Stephen W Waterman, p. 46 of the April issue.

First, express the depth of the compressive area as a fraction of the known distance d instead of a fraction of a. This replaces ka by kd. Second, enter the distance from P to T as e', which, using Mr. Waterman's notation, is equal to $e - a/2 + d$. Third, show the distance $jd = d - kd/3$. With these changes, his Fig. 1 becomes Fig. 1(*a*), here shown.



Now, if desired, this figure can be rotated so that the left end is down and it becomes a replica of the familiar figure that portrays the cross-section of a reinforced beam subjected to combined flexure and compression. The solution can then be accomplished by any of the methods or charts devised for such beams.

If moments are taken about the anchor bolts T, the equation of equilibrium is

$$Pe' = \frac{f_c\, b\, kd\, jd}{2} \quad \ldots \quad (A)$$

We also have the textbook formula,

$$k = \frac{1}{1 + (f_s/n f_c)} \quad \ldots \quad (B)$$

Neither of these equations is complex. By using trial values for k in Eq. A, and substituting the resulting values of f_c in Eq. B, a solution can be obtained by a few trials and adjustments. A chart or table for the relationships in Eq. B will facilitate the work. This solution can be and has been extended to the case in which compressive steel exists in the kd zone.

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SOCIETY NEWS

President Gail Hathaway Addresses Summer Convention in Louisville

Increased attention to the economic status of engineers was urged as a prime responsibility of the Society by President Gail A. Hathaway in the President's Annual Address given at the ASCE Summer Convention in Louisville—the first Society meeting to be held in that city since the fifth Annual Convention of ASCE in 1873. Emphasizing the influence of membership trends on Society responsibilities, at the opening session on Wednesday morning, June 13, Mr. Hathaway pointed out that about 44 percent of the membership of the Society is now classified as Junior Members, most of them serving as employees. This situation, he said, entails the obligation of the Society to "play a prominent part in assuring that adequate salary scales be established and adhered to."

He warned that, "Although many talented individuals will undoubtedly continue to enter and follow the engineering profession despite inadequate compensation, records demonstrate that the increasingly unfavorable economic status of engineers in relation to other professions and trades is having a strong influence in reducing the supply of engineers below a safe level for national requirements."

Mr. Hathaway's address appears elsewhere in this issue.

Engineering Manpower Shortages

Engineering manpower shortages were also discussed by Henry T. Heald, president of the Illinois Institute of Technology, in the other major talk at the opening session. Speaking on "What Lies Ahead in Engineering Education," Dr. Heald stressed the need for an adequate manpower policy and upheld recent extension of the deferment powers of Selective Service for men engaged in, or preparing for, essential occupations.

Despite the effective work of such groups as the EJC Engineering Manpower Commission, there is little evidence that freshman enrollment next fall will increase, he said, warning that the "critical shortage of scientific and engineering manpower presents a serious threat to the safety of the country. Aside from its civilian impact, it will impair our military effectiveness, which is dependent not only on our fighting forces and our ability to manufacture new weapons and equipment, but also on the research and development work which makes such things possible."

Dr. Heald opposed the decision of several institutions to accelerate their curricula as a means of meeting the situation. He asserted that any good result of this procedure, a temporary increase in the number of graduates, can be obtained only by sacrificing the quality of the education. "In the long run," he said, "this method of meeting the difficulty will contribute neither to the national security nor to the peacetime welfare of the country."

Wednesday Membership Luncheon

The stepped-up construction program of the Corps of Engineers, geared to meet defense needs, was described in the principal talk at the Wednesday membership luncheon by Brig. Gen. C. H. Chorpening, Assistant Chief of Engineers for Civil Works. Substituting for Maj. Gen. Lewis A. Pick, Chief of Engineers, who had been scheduled to speak but was unavoidably detained, General Chorpening outlined developments of special interest to the profession in the military construction program.

Craig P. Hazelet, president of the Kentucky Section and presiding official at the luncheon, compared the present-day status of the profession with its

THE ROLE OF THE ENGINEERING PROFESSION in emergency military construction is discussed by Brig. Gen. C. H. Chorpening, Assistant Chief of Engineers for Civil Works, at general membership luncheon on Wednesday, June 13.

ASCE PRESIDENT GAIL A. HATHAWAY received Kentucky colonelcy during Society's Summer Convention in Louisville. Shown with him here are Craig P. Hazelet (left), president of Kentucky Section, and Charles W. Lovell, general meeting chairman.

status in 1873 as exemplified by the technical programs then and now.

The tremendous development of the profession was further attested in the programs of the eleven Technical Divisions scheduling one or more sessions.

OPENING SESSION OF AUTHORS' BREAKFASTS typifies technical program arranged by eleven ASCE Divisions at Louisville Convention. Shown here, left to right, are Samuel Bailey, chairman of technical committee; George R. Schneider, chairman of Executive Committee of Hydraulics Division; and Charles W. Lovell, general convention chairman.

ASCE COMMITTEE ON SALARIES meets in Louisville during summer convention week. Reading clockwise around table are Allen P. Richmond of Headquarters staff, Chairman R. A. Monroe, Ray E. Lawrence, H. E. McGee, Z. E. Sevison, and Director Paul L. Holland.

Projects and subjects under discussion included the new Delaware Memorial Bridge, the Veterans' Memorial Bridge across the Mississippi, the York River Bridge in Virginia, the New Jersey Turnpike, the Blue Ash Airport at Cincinnati, and air navigation aids. A number of the Convention papers are featured in this issue. Others will be published later.

Inspection trips to a number of local projects, including the Louisville Floodwall, the Paddy Run Steam Power Plant of the Louisville Gas & Electric Co., and the Ohio River Harbor installations, supplemented the technical program.

Diversified Program of Entertainment

Other tours of a more recreational nature took the group through the scenic Bluegrass region of Kentucky, to the historical places of interest in the area, and on an all-day excursion to Mammoth Cave. The program included a series of Authors' Breakfasts, special entertainment for the ladies, the traditional dinner-dance, and a smoker for the men sponsored by the District 9 Council.

All during Convention week ASCE officers publicized the Society and the profession in addresses given before various civic organizations and in radio broadcasts. These features included a talk at a Rotary Luncheon by President Hathaway on his recent trip to the international engineering conferences in India.

A number of committees, under the general chairmanship of Charles W. Lovell, were active in arranging the program. Assisting Mr. Lovell were Mr. Hazelet in his capacity as president of the Kentucky Section, and Wallace W. Sanders and Floyd F. Schrader as vice-chairmen. The Technical Committee was headed by S. M. Bailey, and the Ladies' Committee by Mrs. Bailey.

Board of Direction Actions at Louisville Briefed

Several of the actions taken by the ASCE Board of Direction at its meetings in Louisville, Ky., June 11-12, 1951, are noted here. All members of the Board were present, with President Gail A. Hathaway in the chair.

Civil Defense by Local Sections

Local Sections were requested to give further attention locally to engineering aspects of civil defense and to assume primary responsibility to the Society in furthering the work. Director Frank L. Weaver, Board Contact Member on the Committee on Local Sections, was named liaison official between the Board of Direction and the Federal Administrator of Civil Defense.

Change Recommended in EJC Water Policy Panel Report

Conceding that it is objectionable to completely disbar present and former employees of federal agencies from the Board of Impartial Analysis recommended in the EJC Water Policy Panel Report, the Board of Direction recommended to the Panel that the objectionable language in Section 21, Appendix IX, of its report be deleted and the following words or words having the same meaning be substituted:

"The membership of such a board should consist of thoroughly qualified personnel provided with adequate staff, and each member of the board shall affirm that he is in a position to exercise free and independent judgment uninfluenced by any past or present association, engagement or affiliation. A reasonable proportion of the membership of the board should be selected from a list nominated by Engineers Joint Council or some like

qualified body representative of the engineering profession."

New Technical Division Considered

A petition for the formation of a Technical Division on Engineering Management was reviewed and referred to the Committee on Technical Procedure for study and report at the October 1951 meeting.

Professional Unity Under Study

After hearing the report of ASCE Past-President R. E. Dougherty, who represents the Society on the EJC Conference on the Increased Unity of the Engineering Profession, the Board concurred with the recommendation of its Executive Committee to postpone decision on any of the four proposed plans until more Local Sections and past officers respond to questionnaires sent to all of them.

Progress on Centennial Celebration Plans Reported

Concerning the planning of the ASCE Centennial Celebration, Carlton S. Proctor, vice-president of the Centennial of Engineering, 1952, Inc., reported that plans for financing have become definite. He described progress on the program for the Engineering Exposition and the Convocation. Further action in support of a petition to the Postmaster General for the issuance of a postage stamp in 1952 to mark the ASCE Centennial Celebration was recommended.

Future Convention Dates Set

Conventions of the Society were agreed upon at the following places and dates: San Francisco, Calif., February 27 to March 6, 1953; Miami, Fla., June 15 to 19, 1953; Atlanta, Ga., during the month of February 1954; and Atlantic City, N.J. (Philadelphia Section), during the week beginning June 14, 1954.

More Proceedings Separates

On recommendation of the Committee on Publications the Board authorized a change in the annual subscription price for all Proceedings Separates from $3.00 to $5.00 and an increase on individual orders without additional charge from 25 to 40 annually.

Registration Committee to Cooperate with ECPD

A proposal for closer cooperation between the Committee on Professional Recognition of ECPD and the ASCE Committee on Registration was considered. The Board voted for the present to arrange for close cooperation on a joint committee basis between the ECPD and ASCE committees named.

Survey of 1951 Salaries Completed

The Board directed early publication in CIVIL ENGINEERING of the report of the Committee on Salaries covering its survey of 1951 salaries.

An extensive manual, "Job Evaluation and Salary Surveys," prepared under guidance of the Committee on Salaries was reported virtually ready for publication.

Fenn College Student Chapter Approved

The establishment of a Student Chapter at Fenn College was approved on recommendation of the Committee on Student Chapters.

Director Goodkind's Term Extended

Due to the recent change in the Society Constitution and the reduction in the number of Directors credited to District 1, it was necessary for the Board to extend the term of either Director Waldo Bowman or Director Morris Goodkind on the Board of Direction from January 16, 1952, to October 1952. On the basis of a recommendation from the Metropolitan Section, decided by lot, Director Goodkind was recommended for the extended term, and the Board so voted.

UPADI Constitution Approved

The constitution of the Union Panamericana de Asociaciones de Ingenieros (UPADI), a federation of national engineering societies of the nations of the Western Hemisphere, as adopted April 21, 1951, at a constitutional convention held in Havana, Cuba, was approved on recommendation by EJC.

Prizes and Awards

The Board approved Prize Committee recommendations for the 1951 prizes and awards, listed elsewhere in this issue.

ASCE Annual Convention to Be Held in New York in October

A completely new and expanded program of Convention activities is being planned by the ASCE Annual Convention Committee. First, the time of year is new—the 1951 Annual Convention will be held during the week of October 22 to 26. Second, more activities are scheduled than ever before, with Division sessions, social events and excursions to be held throughout the week, Monday through Friday. Starting on Saturday of the Convention week, there will be a post-convention cruise to Bermuda and Nassau.

The largest technical program ever arranged by the Society lists over 30 sessions. To permit scheduling of this extensive technical program without serious conflicts in the time schedule, the sessions will be held throughout the Convention week, from Monday through Friday. Nearly all the Technical Divisions will present several sessions of marked professional interest.

Engineering Mechanics Division Inaugurates Program

Of special interest to many engineers will be the program of the newly organized Engineering Mechanics Division. Inaugurating its program of technical sessions, the new Division has planned a full day of specialized activities including a luncheon which will mark the expansion of ASCE in this important professional field. Committees and authors have been preparing for these sessions under the Division chairman, Dr. L. E. Grinter, since the authorization of the Division in 1950.

Several of the Divisions have scheduled excursions to some of the many places of professional interest in and around New York. In the field of interest of practically any one of the Divisions, there are projects in the New York area to attract the engineer's interest.

October Offers Reliable Weather

A principal consideration of the ASCE Board in selecting October for the Annual Convention in New York City was the uniformly pleasant weather characteristic of that month in New York. Those who have struggled through blizzards to attend the January Conventions and then been "hotel-bound" during the Convention days will be appreciative of this complete change.

The change to October was made possible by the revision of the ASCE Constitution last year, shifting the time of all conventions and Board sessions.

Extensive Facilities Available

To accommodate the vastly expanded Annual Convention, a new and more commodious headquarters hotel—the Statler—has been selected. Located on Seventh

Avenue at 33rd Street, the Statler is directly across the street from the Pennsylvania Railroad Station, with underground corridors connecting the two. In addition to the usual direct services to railroads, air and bus terminals, the Statler has a subway station in its basement and complete parking service for those who are driving to the Convention.

Designed as a convention hotel, the Statler has the number and type of meeting rooms that will assure all facilities for successful sessions of the Technical Divisions and the numerous social events planned. Shops and services of every sort are in or connected directly to the hotel and major shopping centers are adjacent.

Extensive Social Program Offered

Extensive entertainment is planned for the entire Convention week. Highlight of the social program will be the annual dinner-dance, a formal party consisting of a reception, entertainment, banquet and dancing. One evening will be given over to the traditional Men's Smoker. Another will schedule college dinners.

A membership luncheon with a keynote address will be featured one noon, and on other days the various Divisions will sponsor luncheons with programs of special interest. One of these is the New Jersey Turnpike luncheon sponsored jointly by several Divisions. This luncheon will be the "kickoff" for a series of sessions on the turnpike, climaxed by a general bus excursion over the route of the new superhighway, which runs the length of New Jersey.

Special attention has been given to entertainment of the wives who will be accompanying their husbands to the Annual Convention. Several parties and excursions have been planned especially for them, and on the evening of the Men's Smoker there will be a special Ladies Social to bring the wives together. As an entertainment capital, New York has a vast variety of features that have been drawn upon by the Ladies Committee to provide events of interest to all.

A Post-Convention Tour Available

The post-convention tour has become an established feature of ASCE conventions. More engineers are including such tours in their vacation plans, with all the added enjoyment of congenial traveling companions. The Annual Convention Committee continues the traditional Bermuda cruise, with the added interest of a stop at Nassau. Leaving New York Harbor on October 27, aboard the *Queen of Bermuda*, the tour will return to New York on November 3. A luxury cruiseship built especially for the Bermuda run, the *Queen* has been completely reconditioned for the pleasure excursion service. Its schedule has been arranged especially for the convenience of those attending the Annual Convention. The all-inclusive price for this tour, beginning at $197.35, includes all taxes.

To assure reservations, choice of staterooms must be made early. Full information pamphlets are available on request from Leon V. Arnold, 36 Washington Square, West, New York 11, N.Y. Mr. Arnold is the travel consultant who has been in charge of similar ASCE post-convention cruises in past years.

Program in the September Issue

The full Convention program will be printed in the September issue of CIVIL ENGINEERING.

Honorary Degrees Go to Society Members

As usual during the commencement season, ASCE members are conspicuous on lists of professional leaders receiving honorary degrees from colleges and universities. During the current season word has been received of such awards to President Gail A. Hathaway, to Past-President Ernest E. Howard, and to two Honorary Members—Theodore von Karman and Gen. Lucius D. Clay.

President Hathaway received the honorary degree of doctor of engineering from Drexel Institute of Technology on June 16. He was cited in part as an "able man of science, hydraulic engineer of international eminence, and devoted public servant."

Past-President Howard was awarded the honorary degree of doctor of science from the University of Missouri at its commencement exercises on June 8; Dr. von Karman, the honorary degree of doctor of science from Yale University on June 12; and General Clay, an honorary degree from Williams College on June 17.

Send in Yearbook Data

Already there has been considerable response to the cards sent out early in June asking for information for the 1952 Yearbook. Please remember that if Yearbook changes in title or address are required, the card should be returned before September 30, 1951. The card should not be returned if changes are not needed. For the convenience of members who may have misplaced the cards mailed them, a duplicate form appears in the advertising section of this issue. If you return the card previously sent, or the coupon in the advertising section of this issue, be sure that all the blanks are filled in.

EJC Manpower Commission Originates News Letter

A news letter has been mailed by the Engineering Manpower Commission of Engineers Joint Council to the 3,800 or more local draft boards throughout the country, according to S. C. Hollister, M. ASCE, dean of the Cornell University College of Engineering and chairman of the Editorial Committee of the Engineering Manpower Commission. The purpose of the news letter, which is entitled "Industrial Internship—a National Necessity," is to aid members of local draft boards in considering requests for deferment based upon participation in industrial training. It sets up four questions that may be used as criteria for judging such deferment cases.

The members of the editorial committee, in addition to Dean Hollister, are H. N. Muller, assistant to the vice-president in charge of engineering of the Westinghouse Electric Corp., and M. H. Trytten, director of the Office of Scientific Personnel of the National Research Council.

Society Receives ECA Certificate

THE ECONOMIC COOPERATION ADMINISTRATION

CERTIFICATE OF COOPERATION

awarded to

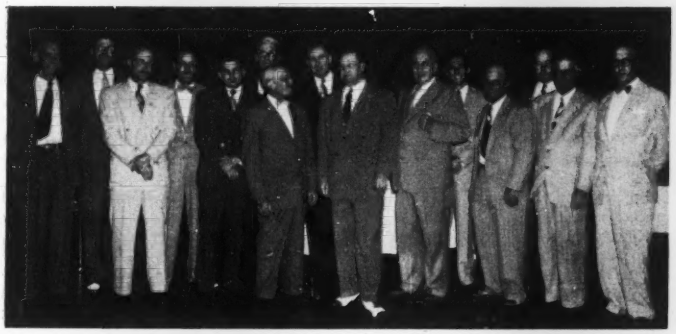
American Society of Civil Engineers

for furnishing technical assistance to the Peoples of the Marshall Plan Countries to aid them in maintaining individual liberty, free institutions and peace.

April 3, 1951

ASCE IS AWARDED Certificate of Cooperation from Economic Cooperation Administration "for furnishing technical assistance to the peoples of the Marshall Plan Countries to aid them in maintaining individual liberty, free institutions, and peace." Certificate was presented in recent ceremony in City Hall (New York) Chambers.

Savannah Subsection of ASCE Is Formed



GROUP OF GEORGIA SECTION MEMBERS living in Savannah area meet at DeSota Hotel in that city to organize Savannah Subsection. Attendance included Col. Moses E. Cox, Section President, and Vice-Presidents Warren S. Mann and H. C. Carter, who presided. Harry Sugden was elected president of new group; Eugene A. Stanley, vice-president; and Julian Attaway, secretary-treasurer. Shown here, left to right, are Harry Sugden, Daniel E. Sewell, Robert Erlenkotter, Charles F. Trainor, James W. Adams, George A. Belden, H. Gray Carter, Warren Mann, Moses Cox, Olaf Otto, Julian J. Attaway, Thomas H. Whitfield, Jr., J. Leo Zwahlen, Eugene A. Stanley, and Andrew S. Goebel.

E. S. Library Revises Its Photoprint Services

To save time and trouble in trying to locate material for photoprinting, the Engineering Societies Library has revised its photoprint service. For material in the library, copies can be supplied as negative prints, white on black, for 40 cents, with a minimum charge of $1 an order. Facing pages with total measurements not greater than 11 × 14 in. can be taken on one print. Search will be made on request for material not in the library, and if available elsewhere there will be the regular charge of 40 cents a print plus a $3 service fee for locating the material. No charge will be made if the material cannot be found.

Members of the Founder Societies ordering work for their personal use will be given a 20 percent discount on the charge for locating the article and a reduction of 5 cents on each photoprint.

ASCE Prizes and Awards Are Announced by Board

ASCE Prizes and Awards for 1950 were announced by the Board of Direction at the Louisville meeting. Presentation will be made at ceremonies held during the Annual Convention in New York in October. Further details, together with brief biographies of the winners, will appear in the October 1951 issue of CIVIL ENGINEERING.

Norman Medal

D. B. STEINMAN, M. ASCE, for Paper 2420, "Aerodynamic Theory of Bridge Oscillations."

J. James R. Croes Medal

M. E. VON SEGGERN, Assoc. M. ASCE, for Paper 2391, "Integrating the Equation of Nonuniform Flow."

Thomas Fitch Rowland Prize

WILLIAM K. BOYD, M. ASCE, and C. R. Foster, Assoc. M. ASCE, for Paper 2406-J, "Design Curves for Very Heavy Multiple Wheel Assemblies."

James Laurie Prize

HANS H. BLEICH, M. ASCE, for Paper 2416, "Frequency Analysis of Beam and Girder Floors."

Arthur M. Wellington Prize

A. HRENNIKOFF, M. ASCE, for Paper 2401, "Analysis of Pile Foundations with Batter Piles."

Collingwood Prize for Juniors

JOHN W. FORSTER, Jun. M. ASCE, and Raymond A. Skrinde, Jun. M. ASCE, for Paper 2415, "Control of the Hydraulic Jump by Sills."

The J. C. Stevens Award

JAMES S. HOLDHUSEN, Jun. M. ASCE, for discussion of Paper 2409, "Diffusion of Submerged Jets."

Karl Emil Hilgard Prize

M. L. ALBERTSON, Jun. M. ASCE, Y. B. Dai, R. A. Jensen, and Hunter Rouse, M. ASCE, for Paper 2409, "Diffusion of Submerged Jets."

Leon S. Moisseiff Award

LING-HI TSIEN, for Paper 2383, "A Simplified Method of Analyzing Suspension Bridges."

Construction Engineering Prize

J. G. TRIPP, M. ASCE, for paper in March 1951 issue of CIVIL ENGINEERING, entitled "Will a Construction Cableway Fit Your Job?"

Accountant Walter Jensen Retires from ASCE Staff

Walter Jensen retired on May 31 as accountant and cashier after 32 years in the service of the Society. He expects to make his home in Florida. Before joining the Headquarters staff in 1919,

WALTER JENSEN

Mr. Jensen was connected with the Chase National Bank and the Panama Steamship Line, and during the first World War he served in the Navy. He was born and educated in Copenhagen, Denmark.

A group of almost 100 present and former employees from the Headquarters staff gathered at dinner on May 29 to honor Mr. Jensen.

FROM THE NATION'S CAPITAL

JOSEPH H. EHLERS, M. ASCE — Field Representative ASCE

NPA Construction Controls

With the recent amendments to NPA order M-4, and the issuance, late in June, of the Controlled Materials Plan for Construction, CMP Reg. 6, virtually all engineering construction is now regimented. The new CMP regulation for construction is announced as a permissive rather than a mandatory plan, but at this writing it would appear extremely difficult to build anything more than a few small houses without reference to the new rules.

Form CMP-4C is the application form on which to apply for critical materials needed for any structure as well as for authority to start construction as required under order M-4. Thus the NPA licensing and the materials assistance may be handled in one operation. The form is to be submitted to the claimant agency designated for the particular type of work. Thus for a highway bridge, the matter is handled with the Bureau of Public Roads; for water and sewage projects and for industrial facilities, with the National Production Administration. In this latter case the nearest office of the Department of Commerce (also serving as the field NPA office) handles the application. Critical materials for the project have to be specified in detail by quarters.

Form CMP-4C is not to be filed for construction work for the Department of Defense (Army, Navy and Air Force) nor for the Atomic Energy Commission unless specifically requested by those agencies.

Also, for electric power facilities and oil and gas facilities, special procedures will be used as prescribed in NPA orders M-46B and M-50.

New orders may be expected to cover a self-allotment procedure for small jobs, procedures for maintenance and repair, and other details not yet covered.

When an allotment of critical materials (steel, copper and aluminum) is made, full priority status is given. It is just as much a mandatory order on the supplier to deliver on schedule as though it were an order for military goods or atomic energy equipment. Of course that does not mean that expediting will not be as essential as ever. Once an allotment is made for critical materials, an automatic priority is available for all the non-critical materials essential to the project. Applications should be submitted at once for September deliveries. It is expected by NPA officials that steel will be difficult to get during the fourth quarter of 1951 without a CMP rating. The CMP rating obtained by the principal (owner, engineer or general contractor) is a certified draft on a reserved stock of materials and may be passed on to subcontractors and materials suppliers.

It is expected that the burden of filing the CMP forms will fall on the engineer for the project, although on projects already under construction, the general contractor may handle this procedure. Copies of the new CMP Reg. 6 and of the new form CMP-4C and information about them may be obtained from any field office of the U. S. Department of Commerce. The ASCE Field Representative will also supply copies on request.

Legislation Pending

H. R. 3798 proposes the establishment of a Commission on Aid to Underdeveloped Foreign Areas. The 14-man Commission would be composed of 2 members from the Senate, 2 from the House, 4 from the Executive Branch of the government and 6 from private life. The Commission would study the problem of aiding underdeveloped areas and recommend specific programs for carrying out the Point IV Program. No hearings have yet been held or scheduled.

S. 1166 provides for the creation of a Commission to study overseas activities of the Government and make recommendations to Congress. The 12-man Commission would consist of 4 Senators, 4 Representatives and 4 persons from the Executive Branch.

S. 1164, Economic Cooperation Act, mentioned in this column in May, is still awaiting action in committee.

S. 622 and H. R. 241 provide pay increases for Civil Service employees. The Senate Civil Service Committee has agreed on an 8.8 percent pay raise with a maximum increase of $800 per year. Hearings are under way before the House Committee.

S. 75, the Central Arizona project, passed the Senate with an amendment prohibiting any appropriation until the end of the present national emergency. The House previously voted to delay action on its corresponding bill until the disputed rights of Arizona and California were adjudicated.

S. 349, the Defense Housing Bill, which has passed the Senate, is pending before the House Committee and is expected to be reported out of committee in June.

H.R. 6 and H.R. 7 provide for a research program to develop a cheap method of converting sea water into drinking water and to produce rain artificially. Hearings have begun.

Various bills have been introduced on the subject of air pollution. H.J. Res. 218 and H.R. 3536 provide for research on air pollution, while H.R. 134 relates to a study of smog at airports. No action has been taken or scheduled on these measures. A committee of Engineers Joint Council is studying the proposals.

No action has been taken or is yet scheduled in Congress for the following bills previously reported: H.R. 2940, Fair Labor Standards Act of 1938; H.R. 1637, National Water Resources Basic Data Act; S. 644, Bacon-Davis Act amendment; H.R. 2752, Industry Waste Treatment; S. 1144, Board of Analysis for Engineering and Architectural Projects and Drainage Area Advisory Commissions.

Congress has been asked for authority to spend $6.5 billion on military public works in the United States and overseas. An appropriation of $4.5 billion would be needed for the fiscal year 1952. The House is also considering a $544 million Army Civil Functions Appropriation bill.

P.L. 51, Universal Military Training and Services Law, permitting the draft of 18½-year-olds, was signed by the President on June 19, 1951.

Washington, D.C.
June 23, 1951

ASCE MEMBERSHIP AS OF JUNE 8, 1951

Members	7,853
Associate Members	10,140
Junior Members	14,326
Affiliates	68
Honorary Members	36
Fellows	1
Total	32,424
(June 9, 1950	28,929)

ECPD Makes Available New Issue of Guidance Manual

Issuance of a new guidance manual intended for engineers who are aiding young men interested in the engineering profession is announced by the Engineers' Council for Professional Development. The 15-page pamphlet, prepared by the ECPD Guidance Committee, urges members of engineering societies and organiza-

tions to establish guidance committees to help high school students decide if they are qualified for careers in engineering.

Supplementing the guidance manual is an appendix entitled "Shall I Study Engineering?" This is a questionnaire to be filled out by the student for use of the engineer who is advising him.

Copies of the manual with the questionnaire may be obtained from ECPD, 29 West 39th Street, New York 18, N.Y., at 20 cents each. The manual may be purchased for 15 cents, and the questionnaire for 10 cents. A deduction of 25 percent is allowed for purchases of 25 or more.

Student Chapter Initiated at University of Denver

The University of Denver Student Chapter, authorized by the Board at its Houston meeting, received its charter at the recent annual Student Chapter Night of the Colorado Section. Presentation of the charter was made by Leo C. Novak, member of the ASCE Committee on Student Chapters, before an audience of almost 250, which included large delegations from the Colorado Agricultural and Mechanical College and the University of Colorado. Professor Novak prefaced the presentation with a talk on the Society's purpose in having Student Chapters. The charter was accepted on behalf of the newly organized Chapter by Robert Greenwald, Chapter president.

Coming Local Section Events

Illinois—Weekly luncheons every Friday at the Chicago Engineers Club, at 12 noon.

South Carolina—Meeting at the Clemson House, Clemson, S.C., on July 27 and 28, with ladies invited.

Scheduled ASCE Conventions

ANNUAL CONVENTION
New York, N.Y., October 22–26

SPRING CONVENTION
New Orleans, La., March 5–7, 1952

SHOWN AT SITE OF CORALVILLE DAM, IOWA CITY, are P. H. Switzer (left) resident engineer for Rock Island District Office of Corps of Engineers on project, and R. G. Stearns, president of Tri-City Section. Mr. Switzer conducted tour of project preceding recent joint meeting of Iowa and Tri-City Sections with University of Iowa and Iowa State College Student Chapters, which was attended by 118. Visit to project implemented technical program consisting of talk on "Design and Construction of Small Earth Dams" by Ake L. Alin, professor of hydraulic engineering at University of Iowa. Prof. Chesley J. Posey is president of Iowa Section, which was host to joint meeting at Iowa City.

News of Local Sections Briefed

SECTION	DATE	ATTENDANCE	PROGRAM
Akron	May	15	Dinner meeting featuring Steve Parker, of Ohio Highway & Turnpike Association, as speaker.
Alabama	June 15–16	76	Summer meeting. Constitution, as submitted by District 10 Council, adopted. Proposed state legislation affecting the Board of Registration discussed. Civil defense was theme of meeting. Speakers included Col. W. K. Wilson, Jr., district engineer, Corps of Engineers, at Mobile, Ala.; Reese Harvey, office engineer, State Highway Department; Paul Keefe, director of personnel, Alabama Dry Dock & Shipbuilding Co.; Commdr. G. S. Robinson, U.S. Navy Civil Engineer Corps, Pensacola, Fla.; and Gen J. A. Mollison, Civil Defense Director of Mobile.
Buffalo	May 15	46	Luncheon meeting with panel discussion on "New York State Thruway and Its Effect on the City of Buffalo." Participants included Charles R. Waters, district engineer, New York State Department of Public Works; Elmer G. H. Youngman, assistant district engineer, State Department of Public Works; and Edward J. Nunan, executive vice-president, Buffalo & Erie County Planning Association. A film entitled "The Thruway to Tomorrow" was shown.
Central Illinois	May 24	42	Dinner meeting. Three-dimensional structures were discussed by Prof. R. LeRicolais, University of Illinois. Kenneth C. Naslund received Student Award. H. E. Babbitt was presented Life Membership Certificate. Prof. E. D. Ebert, of University of Illinois, succeeds Prof. James Halsey as editor of Section's "Civil Engineering News."
Central Ohio	May 17	85	Joint meeting with Ohio State University Student

			Chapter. Section prize of $10 was awarded to Arthur A. Miller, graduating Student Chapter member, in recognition of his scholastic standing. The Simpson Prize was presented to Richard Welch Bletzacher, Chapter member, for his thesis entitled, "An Economic Comparison on a Three-Span Continuous Steel Beam Highway Bridge Designed by the Standard Method and by the Composite Method."
Cincinnati	May 2	22	Carl Renz, engineer for Ohio River Division Laboratories, at Cincinnati, reported on professional unity, and George Howie, traffic engineer for Cincinnati, outlined city's traffic problems. Newly elected officers include Emil S. Birkenwald, president; Harry A. Balke, vice-president; and Sven E. Sjodahl, secretary-treasurer.
District of Columbia	May 15	84	Luncheon meeting. Maj. Gen. Ulysses S. Grant, III, vice-president of George Washington University, described engineering works of George Washington and showed pictures of the remains of the masonry locks on Washington's canal project to bypass the Great Falls of the Potomac.
Illinois	May 25	...	Luncheon meeting featuring presentation of Junior membership prizes to Frank E. Blake and Ronald A. Hoefle, University of Illinois Student Chapter members; Donald B. Helm and William B. Olson, Northwestern Chapter members; and Robert J. Macur and Donald Walsh, Illinois Institute of Technology members.
Indiana	May 23	180	Joint meeting with Student Chapters of University of Notre Dame, Rose Polytechnic Institute, and Purdue University. ASCE President Gail A. Hathaway spoke on the engineering profession. Junior membership awards of Section went to Student Chapter members: Jack C. Steinsberger, R.P.I.; Richard O. Albright, Alan J. Baxter, and George W. Connell, Purdue; and Robert C. Schwendler, Notre Dame. Junior membership prizes, sponsored by Purdue civil engineering and engineering mechanics faculty members, were given to Robert C. Schneebeli and Paul W. Scheele.
Los Angeles	May 9	171	Meeting at California Institute of Technology with open house in afternoon. Evening program included talks by ASCE President Gail A. Hathaway on "Unity in the Engineering Profession," and Dr. A. Jan Haagen-Smit, professor of bio-organic chemistry on "Smog." The Section's annual prizes of Junior membership in the Society, with entrance fees and dues paid, went to Goro Yamada of University of Southern California and Robert Munro of California Institute of Technology.
Mid-South Jackson Branch	May 31	15	Drainage and irrigation on Mississippi delta farms was outlined by Harold N. Estes, district drainage engineer for the Soil Conservation Service, at Clarksdale, Miss.
Pittsburgh	May 22	200	President Gail A. Hathaway discussed engineering affairs at joint meeting of Section with faculty and student members of the University of Pittsburgh and Carnegie Institute of Technology. Inspection of Lock No. 2 on Monongahela River with Col. C. P. Hardy explaining work in progress. Dinner meeting concluded program. Annual awards were presented to Richard Dressel, University of Pittsburgh, and George Mostoller, C.I.T.
Virginia	May 18–19	200	Joint meeting with Engineers Club of Hampton Roads and of the Virginia Peninsula. ASCE Director William R. Glidden spoke on various plans for unity in the engineering profession. Other speakers included N. W. Dougherty, dean of engineering, University of Tennessee; G. J. Murphy, resident engineer, Norfolk-Portsmouth vehicular tunnel; and C. C. Johnson, engineer-in-charge of pilotless aircraft design, National Advisory Committee for Aeronautics, Langley Air Force Base. Inspection tour of Norfolk-Portsmouth Tunnel.

STUDENT CHAPTER NOTES

David L. Crowson, graduating senior in the engineering school at the University of Florida and member of the Student Chapter there, has been named co-winner of the Eschenbrenner Award of $500, sponsored by the Universal Concrete Pipe Co., of Columbus, Ohio. Robert C. Deen, member of the University of Kentucky Student Chapter, is one of three recipients of $100 honorable mention awards in the same contest. The awards were established last year "to stimulate original thinking among civil engineering students in the design, fabrication, and use of concrete products."

D. L. Crowson

Manhattan College

A series of motion pictures on the source, manufacture, and use of asphaltic cement products, were presented at recent meetings of the Manhattan College Student Chapter, under the sponsorship of the Metropolitan Section with the cooperation of the Asphalt Institute. At another recent meeting with the student post of the Society of American Military Engineers, the advantages and applications of insulation were described by engineers with the Olsen Insulation Co.

Waldemar D. Stopkevyc is the 1951 recipient of the Frank L. Flynt Memorial Award. The award is made by the Tri-City Section of the Society in cooperation with the Student Chapter at the Missouri School of Mines and Metallurgy, to the outstanding Student Chapter member, who is in his junior year in the department of civil engineering. Mr. Stopkevyc, whose major interest is in the field of structural design, is the top student in the department and also holds the highest average of any junior in the School of Mines.

W. D. Stopkevyc

NEWS BRIEFS . . .

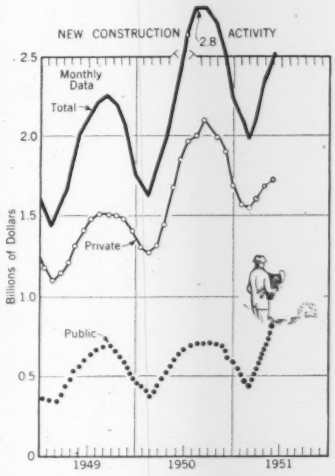
Construction in May Rises Slightly Despite Drop in Home Building

A drop from April in new home-building expenditures kept total new construction outlays for May, amounting to $2.5 billion, from the seasonal advance usual at this time of year, according to a joint release of the Building Materials Division of the Department of Commerce and the U.S. Labor Department's Bureau of Labor Statistics. The relatively small (6 percent) advance this May is attributed to substantial increases in defense plant and military construction and to seasonal expansion of most types of non-residential building and heavy construction work.

The decline in residential building activity, according to the joint agencies, reflects the drop in new housing started during the winter and the further downturn in April. The total value of new private residential buildings put in place amounted to $854 million, 3 percent less than in April, and 18 percent less than in May 1950. This further drop in home building kept private expenditures for new construction at about the same level as a year ago, in spite of substantial increases over the year in commercial, industrial, public utility, and most other types of non-residential building.

Public construction outlays for the month, totaling $813 million, were 17 percent above April and 39 percent above May 1950. Atomic energy and other defense plants, military facilities, and highway work accounted for most of the increase.

During the first five months of 1951, new construction with a total value of $11,149 million was put in place, compared with $9,400 million in the corresponding period of 1950—a 19 percent increase. Total private outlays of $8,085 million were 15 percent above expenditures for the corresponding period a year ago, and public expenditures of $3,064 million represented an advance of 30 percent.



CONSTRUCTION ACTIVITY IN MAY, shown in Department of Commerce curves, is 6 percent above April total, despite decline in new home-building expenditures.

Research Organization Formed to Aid BRAB

To provide a common meeting ground for research men from all parts of the building industry, the Building Research Advisory Board has obtained authorization from its sponsoring organization, the National Research Council, for formation of a Building Research Institute. Acting as a liaison agency, the Institute will answer the need of the 30-member Building Research Advisory Board for increased contact with those interested in building research.

Initiated in 1949, BRAB has filled the need for an impartial non-government organization acting as a center of information for research in the building field. Through the Institute, it will now be possible for BRAB to cooperate more closely with members of the industry in improving building research without impairing its independent status.

The newly formed Institute is planning an accelerated publications service. There will also be forums for the benefit of individual members and the building industry as a whole. Membership in the Institute is available under the following classifications: (1) Manufacturers, (2) Contractors, (3) Associations, (4) Participating Memberships, and (5) Professional Memberships. A sliding scale of dues will make it possible for an organization to have representation at meetings of the Institute commensurate with its activities and interest in building research.

St. Louis Receives Advance Funds for Storm Sewer Plans

An $11,860,000 project for construction of storm drainage relief sewers in the Harlem-Baden area of St. Louis and St. Louis County, Missouri, will receive an interest-free advance from the Housing and Home Finance Agency to assist in the preparation of plans and engineering drawings. Existing drainage facilities in the northern section of the city, where there has been intensive industrial and residential development during the past ten years, are reported entirely inadequate to prevent storm-water damage. Serious flooding occurs during heavy rainfall when the series of laterals that flow into two main outlets emptying into the Mississippi cannot handle the runoff.

The project will consist of more than six miles of drainage tunnel, to be lined with bulk concrete and installed through limestone rock, and 4,000 ft of reinforced concrete horseshoe sewer to drain some 10,000 acres of highly industrialized terrain. Horner & Shifrin, of St. Louis, are the engineers on the project.

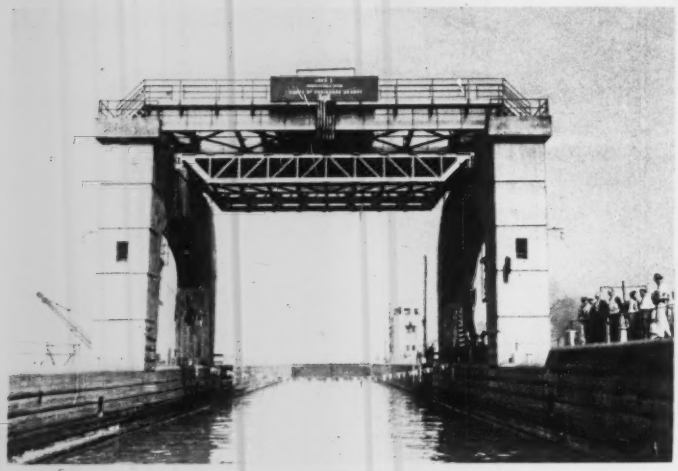
Natural Gas Pipeline Project to Aid Defense Industries

Plans for a $45,300,000 pipeline project that will make available increased supplies of natural gas to defense industries and homes in seven Mid-Western states have been outlined by the Texas Gas Transmission Corp. before the Federal Power Commission. The company stated that more natural gas is urgently required to meet the needs of plants and labor forces devoted to the production of defense materials.

In addition to serving fuel and gas companies in the area, the project would make available 90,000,000 cu ft a day, on an interruptable basis, to the Tennessee Valley Authority at Johnsonville, Tenn. This supply would enable the TVA to meet increasing power requirements of the atomic energy plants at Oak Ridge, Tenn., and Paducah, Ky., as well as other industrial plants.

The company's expansion program includes: (1) Construction of 189 miles of 26-in. pipe linking gas-gathering subsidiaries in southwestern Louisiana with the company's main line in the northeastern part of the state; (2) construction of 412 miles of 26-in. pipeline along its present system from Louisiana to northern Kentucky; and addition of 18,580 compressor hp, including new stations near Shreveport, La., and Madison, Ind.

New Lock Chamber Expedites Monongahela River Traffic



RECENT OPENING OF NEW RIVERWARD $7,263,000 lock chamber at Locks No. 2 on the Monongahela River at Braddock, Pa., completes first half of modernization project designed to accelerate barge deliveries of coal from West Virginia mines to steel mills in Pittsburgh area and other river traffic. New chamber, which is 360 ft long and 56 ft wide, features an emergency dam, supported on an arch just upstream from the upper lock gates. This dam, or floodway bulkhead, can be lowered in an emergency or during routine repairs to prevent loss of the upper pool. During high-water periods bulkhead will be lowered while the miter gates are opened, then raised again to allow increased flow past the fixed dam. Project was constructed for Pittsburgh District of Army Corps of Engineers by the Dravo Corp., which is now under contract for construction of an $8,157,000 landward lock (720 ft long by 110 ft wide), which will complete project.

Three-Basin Committee Studies Resources Planning

Resources planning on a new and broader basis is under way in the Arkansas, White, and Red River basins under the direction of an Arkansas-White-Red Inter-Agency Committee. Established last year by the Federal Inter-Agency River Basin Committee, at the request of the President, the Three-Basin Committee functions under congressional authorization contained in the Flood Control Act of 1950.

The committee consists of representatives of six federal agencies and eight states. The federal agencies are the Departments of the Army, Interior, Agriculture, and Commerce, the Federal Power Commission, and the Federal Security Agency. States represented are Louisiana, Missouri, Arkansas, Texas, Kansas, Colorado, Oklahoma, and New Mexico. The Department of the Army is the chairman agency, with Col. Louis W. Prentiss, division engineer for the Southwestern Division of the Corps of Engineers, Dallas, Tex., chairman.

Covering all phases of land and water development throughout the basin, the study is the most comprehensive ever authorized. The ultimate plan will be based on a series of joint public hearings. In the meantime, two subcommittees—on hydrology and mapping—have been established and their work is well advanced.

In January the Hydrologic Subcommittee submitted a report on water availability and quality at specified critical locations, and a second report on groundwater will follow. The Mapping Subcommittee is performing an inventory of existing maps and developing a priority program of mapping based on the need for orderly project development. Under the auspices of this subcommittee, the U.S. Geological Survey has established a map information office at Tulsa, Okla. The office maintains samples of existing maps throughout the area and acts as an information clearing house on existing and proposed mapping.

To facilitate study and planning, the project has been broken down into 17 subject divisions, with a federal agency as coordinating body for each subject group. Subject divisions include navigation, flood control, drainage, domestic and industrial water supply, irrigation and reclamation, hydroelectric power development and utilization, agriculture, fish and wildlife, recreation, pollution abatement, and mosquito control.

Construction Award Made in Aircraft Expansion Program

The Boston branch of the Turner Construction Co. has received a construction contract for expansion of two East Hartford, Conn., divisions of the United Aircraft Corp. The $20,000,000 aircraft expansion program involves construction of two Connecticut plants—one at Bradley Field, Windsor Locks, and another at North Haven—which will increase the company's production area by more than 1,000,000 sq ft and its defense production force by 10,000 workers.

Designed by Albert Kahn Associated Architects and Engineers of Detroit, the plants will be one-story structures of steel girder and reinforced concrete construction. Each will have 500,000 sq ft of production area, plus considerable office space. Construction will be rushed so that the plants will be ready to receive production tooling by late fall.

New Plants Increase Public Power in Ontario

Water power resources of the Province of Ontario will reach 3,900,000 hp with completion of three major developments on the Ottawa River—at La Cave, Des Joachims, and Chenaux—according to A. E. Aeberli and G. F. Simson, of the Hydroelectric Power Commission of Ontario. The three projects were described at the recent summer meeting of the American Institute of Electrical Engineers in Toronto.

The largest of the stations, at Des Joachims, which operates under a developed head of 135 ft and has a total capacity in eight units of 480,000 hp, was brought into service in 1950. The La Cave development, with a total capacity in eight units of 257,000 hp, will be completed in 1952, and the Chenaux development, with a total capacity of 160,000 hp in eight units, in 1951.

Increase in Manufacture of Clay Products Reported

A substantial increase in production of brick and tile during the first quarter of 1951 is reported by C. Forrest Tefft, president of the Structural Clay Products Institute.

"Shipments of brick during the quarter were up 30 percent over last year, indicating a strong demand when the building season started in the spring," he said. "Output of brick was 28 percent higher than during the same period last year. Total production of brick in 1950 reached six billion, more than any year since 1930." During the same period structural clay tile shipments were 13 percent higher than in the same period of 1950, and tile production increased 10 percent.

Committee Is Formed to Conserve Critical Scrap

Formation of a joint committee representing foundries, scrap dealers, and steel mills to deal with the critical scrap situation is announced by the Committee on Iron and Steel Scrap of the American Iron and Steel Institute. The new agency, which is called the Mobilization Committee for Iron and Steel Scrap, will be headed by Robert W. Wolcott, chairman of the Lukens Steel Co.

The objective of the committee, according to Mr. Wolcott, is "the expediting of iron and steel scrap to steel mills and foundries to maintain maximum steel production." With foundries and steel mills consuming scrap at an unprecedented rate, national inventories have declined to low levels. Both foundries and steel mills may have to curtail output unless the scrap flow is accelerated, he warned.

New Cumberland River Power Unit to Go on Line in August

Wolf Creek Dam and Power Station on the Cumberland River in Kentucky will start producing hydroelectric power in August to meet the needs of the accelerated defense program in the area, according to Maj. Gen. Lewis A. Pick, M. ASCE, Chief of Army Engineers. Two 45,000-kw units will initiate power production at the multiple-purpose project, a key unit in the comprehensive plan for control of excessive flows from the upper Cumberland River watershed. Four other 45,000-kw units will be brought into production by stages over a period extending to November 1952.

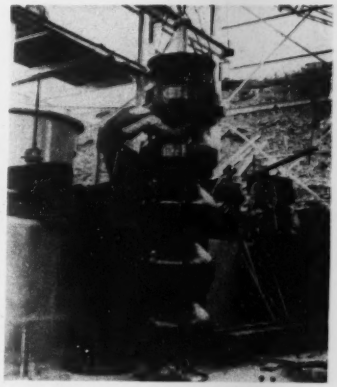
New Foundation Method Is Introduced Here

Formation of the Franki Foundation Co., which will engage in engineering and installing foundations for industrial and commercial construction, is announced by Arthur J. Bulger, M. ASCE, newly elected chairman and president of the organization. The new method, which has been in use abroad for more than forty years, is being introduced into the United States for the first time. Offices of the new company will be in Pittsburgh.

In the new method, the displacement caissons in which the company will specialize are installed from the bottom up, according to Mr. Bulger. In installation, a plug of concrete placed at the bottom of a steel casing is driven into the ground by blows from a solid ram weighing from 2 to 4 tons. When the desired bearing soil strata, or rock, are reached, small quantities of concrete are successively driven out of the casing by the ram to form an enlarged base. As the casing is removed, the shaft is solidly rammed with dry concrete.

One of the principal advantages of this type of displacement caisson, according to Mr. Bulger, is that the concrete is solidly rammed into the soil, connecting it in the vicinity of the caisson before the load is applied. Though especially economical in short lengths, it can be installed to depths of 120 ft when necessary and may be reinforced.

Huge Pumps Installed for N.Y.C. Emergency Supply

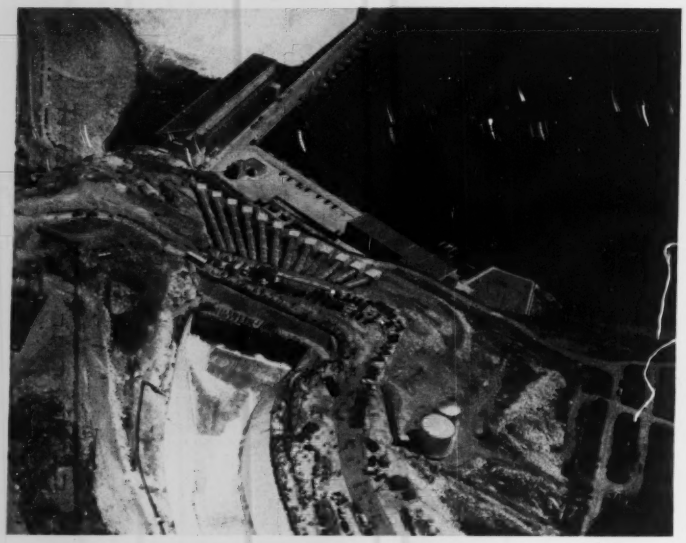


VIEW DURING CONSTRUCTION of new emergency pumping plant of City of New York on Hudson River at Chelsea, N.Y., shows installation of one of six 2,500-hp Peerless vertical close-coupled pumps, said to be largest of their kind in the world. Designed to solve mechanical problem of providing 100 mgd against 575-ft lift, these pumps consist of five stages, with 36-in.-dia bowls and are rated at 14,000 gpm each against head of 600 ft. They are manufactured by Peerless Pump Division of Food Machinery and Chemical Corp., Los Angeles, for the New York City Board of Water Supply.

The Old and New in Bridge Building

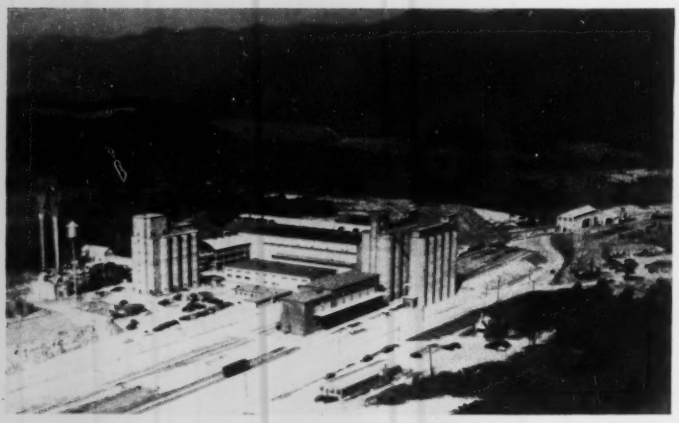
TYPICAL OF STRIDES MADE in past few years in highway and bridge construction in this country are these "before and after" photos—taken by Samuel A. Weakley, M. ASCE, of Nashville, Tenn.—of span on Tennessee State Highway in constant use across Marrowbone Creek 12 miles west of Nashville. Antiquated and dangerous structure which is shown at left, photographed in 1923, was replaced only a few years ago by bridge at right, photographed in 1951.

First of World's Largest Pumps Starts at Grand Coulee Dam



OFFICIAL START OF FIRST of world's largest pumps, in Grand Coulee pumping plant, on June 14 is shown here. Although dam was started 17 years ago, pumping plant, eventually to include 12 pumps, has just been completed. Part of Columbia Basin project of Bureau of Reclamation, project will irrigate initial area of 87,000 acres in vicinity of Ephrata, Wash. Article on this pumping plant appeared in June issue.

Large Cement Mill Is Readied for Operation in Virginia



WITH COMPLETION OF THIS $6,000,000 CEMENT PLANT near Roanoke, Va., Lone Star Cement Co. increases its daily capacity by approximately 4,000 bbl. Embodying latest developments in art of cement manufacture, plant will have annual productive capacity of 1,500,000 bbl of cement and brings to 16 the total number of mills in the Lone Star system. From quarrying to shipping platform, raw material will travel a distance of about a mile and a half. About 150 tons of coal a day will be required to fire the two huge rotary kilns (340 ft long and 10 ft in dia), which are among the largest pieces of moving machinery in the world. Contractors on construction of project were the Walsh Construction Co., of New York, and the Ralph E. Mills Co., of Salem, Va. Silos and packhouse were built by Macdonald Engineering Co., of Chicago.

ASCE Members to Address British Building Congress

Four members of the Society are among the 14 American engineers and scientists scheduled to present papers at the British Building Research Congress, to be held in London from September 11 to 20. They are Prof. George Winter, head of the structural engineering department at Cornell University; R. F. Blanks, chief of the Research and Geology Division of the Bureau of Reclamation, Denver; H. F. Gonnerman, assistant to the vice-president, Research and Development, of the Portland Cement Association, Chicago; and Karl Terzaghi, professor of civil engineering at Harvard University.

The Congress will be in three divisions. The first will cover engineering and structural aspects of building construction, including mechanization and prefabrication; the second, building materials; and the third, the various factors affecting the comfort and efficiency of people using buildings. During the Congress, delegates will have an opportunity to visit a variety of British postwar building projects.

For the benefit of those interested in the Congress but unable to attend, a non-attendance membership has been established. On payment of a fee of $7, such persons will be entitled to receive three volumes of preprints of the papers to be presented at the technical sessions as well as the three volumes of discussions to be published after the Congress. Inquiries should be sent to the Organizing Secretary, Building Research Congress 1951, 57 Onslow Gardens, South Kensington, London S.W. 7, England.

Niagara Falls Will Be Studied in Miniature

Hydraulic characteristics of a 23-mile area of the Niagara River both above and below the Falls will be studied in miniature by means of a model constructed at the Waterways Experiment Station of the Corps of Engineers at Vicksburg, Miss., according to an announcement from the Department of the Army. Remedial works will be designed and tested in an effort to distribute the flow of water through the rapids and over both the Canadian and American sides of the Falls in a way that will permit its maximum use for hydroelectric power without disturbing the beauty of the Falls.

The miniature of the Falls, molded in concrete, has been built to a ratio of 1 ft to 360 ft horizontally and 1 ft to 60 ft vertically. Col. H. J. Skidmore is director of the Waterways Experiment Station.

An International Joint Commission, with members representing the United States and Canada, has been given responsibility for making recommendations concerning the nature and design of remedial works that will distribute the waters over the crest of the Falls in an unbroken line. Construction work will be allocated to both countries.

New Texas Pipeline to Serve New England Area

Construction work on a new 791-mile pipeline of the Texas Eastern Transmission Corp., will begin immediately, with recent authorization of the Federal Power Commission. Scheduled for completion in time for service in the winter of 1951–1952, the new 30-in.-dia pipeline will increase the company's capacity for delivery of natural gas from 740,000,000 to 1,205,700,000 cu ft daily. Of this, 220,000,000 cu ft daily is destined for resale to utilities in Connecticut, Rhode Island, and Massachusetts.

The new line will extend from Kosciusko, Miss., through northwestern Alabama, Tennessee, Kentucky, and southeastern Ohio to Connellsville, Pa., where it will join existing Inch Lines. In addition to the New England area, the enlarged system will provide additional supplies for New Jersey, Pennsylvania, West Virginia, Ohio, and Missouri.

Research Group Develops Insulated Masonry Wall

Development of an important contribution to construction methods in the form of a new type of insulated cavity masonry wall is announced by the Structural Clay Products Institute. The new method, which is called the SCR Insulated Cavity Wall, features a low cost, easily handled, watertight pouring insulation that is said to solve the problem of insulating the hollow space between the interior and exterior walls in cavity masonry wall construction. It can be applied direct to the interior wall surface without furring, lathing, or plastering. Previous attempts to insulate the hollow space in cavity wall construction have proved either unsatisfactory or too costly.

The new method is an initial result of a $1,250,000 research program instituted about a year ago by the Structural Clay Products Research Foundation.

Film on Pennsylvania Turnpike Is Available

Construction of the eastern and western extensions to the Pennsylvania Turnpike is described in a 19-min Kodachrome motion picture, produced by the Portland Cement Association with the cooperation of the Pennsylvania Turnpike Commission. Entitled "Pennsylvania's Great Highway," the 16-mm sound film shows all phases of superhighway building. Scenes were filmed throughout the 327-mile length of the original section of the Turnpike and both extensions.

Copies of the film may be obtained for showing by writing to the Portland Cement Association, 33 West Grand Avenue, Chicago 10, Ill. The name and size of the group to whom it will be shown should be indicated, with at least three choices as to date of showing. A minimum of three weeks' notice should be given.

USBR Test Program Seeks to Reduce Earth Dam Costs

Prototype testing of asphaltic concrete and soil cement as substitute materials for riprap on earth dams will be undertaken soon by the Bureau of Reclamation's Branch of Design and Construction in Denver, following two years of laboratory experiments. Under an $82,890 contract awarded to the Northwestern Engineering Co., of Denver, a test earth embankment will be constructed at Bonny Reservoir in eastern Colorado to evaluate the durability of asphaltic concrete and soil cement as slope-protective materials. The test embankment section will be about 400 ft long and 25 ft high.

It is believed that the full-scale test program may provide an answer to the problem of reducing earth-dam construction costs.

Recent Registration Law Activity Summarized

The new Alaska registration law, which will go into effect June 23, 1951, eliminates the former requirement of a $250 reciprocal registration fee for a single specific engineering project. As the law now reads, the reciprocity requirements are similar to those prevailing in many of the states. In addition to other minor changes, the Alaska law now sets up a category within the major engineering fields. Puerto Rico has currently under consideration legislative changes to bring its law in closer conformity to the Model Law.

States recently making changes in their registration laws include Colorado, which has a new law, with provisions closely following the Model Law; Nevada, whose law was amended by the 1951 legislature; and New York and Pennsylvania, which are both encountering minor changes in fees. The present California legislative session may change the position of professional engineers in that state.

These data on recent registration legislation were supplied by D. B. Steinman, M. ASCE, member of the New York State Board of Examiners of Professional Engineers.

Heavy Earthmoving Equipment Speeds Landslide Removal on Vital Traffic Artery

HEAVY CONSTRUCTION EQUIPMENT eats into 300-ft-high landslide blocking vital California traffic artery in huge spring cleanup operation involving removal of 330,000 cu yd of material. Slide took place on heavily traveled stretch of Bay Tunnel Road between Oakland and Orinda in exceptionally heavy winter rainfall. Heavy earthmoving equipment, rushed to scene, built four-lane detour, 600 ft long, around edge of slide area in 27 hr. Final cleanup, started in mid-April, was accomplished by contractors for State Highway Department using three bulldozer-equipped Caterpillar D7 Tractors, Lorain 75 shovel, and fleet of five 8-cu yd trucks. Loose material was hauled a mile and used as fill along highway. To lessen danger of future landslides, face of bank in slide area will be finished off and compacted and drains installed, 50 ft apart, to carry moisture away from hill. Photo courtesy of Caterpillar Tractor Co.

N. G. Neare's COLUMN

R. Robinson Rowe, M. ASCE

"Pragmatic," said Joe Kerr.

"Prosaic," buzzed Amos Keatow.

"Profound," claimed Cal Klater, "to engender a purely mathematical interest in 108 girls playing leapfrog. In asking how many girls in each of how many columns so as to maximize the number of sorties in a cycle, Professor Neare hasn't even told us how many unknowns there are!"

"I started with two columns," explained Joe Kerr. "Then $a + b = 108$, ab is a maximum, and both are primes, from which I found by trial $47 \cdot 61 = 2{,}867$. Similarly for three columns, $2 \cdot 47 \cdot 59 = 5{,}546$, so this was a step in the right direction. But when I imagined the four columns, $19 \cdot 23 \cdot 29 \cdot 37 = 468{,}901$, the steady rhythm of leaping ladies lulled me to sleep like little lambs hurdling a fence. Imagining five columns put me to sleep every night since, so the problem is practical to a pragmatist."

"A purer pragmatist would have imagined the largest possible number of primes adding to 108," said Amos. Finding $1 + 2 + 3 + 5 + 7 + 11 + 13 + 17 + 19 + 23 + 29 = 130$, or 22 too much, I omitted 3 and 19 to compute $P = 1 \cdot 2 \cdot 5 \cdot 7 \cdot 11 \cdot 13 \cdot 17 \cdot 23 \cdot 29 = 113,503,390$. So simple that it's prosaic."

"Is that so," bellowed Joe. "That lone girl in the first column would break her neck trying to leap over herself. If you're so smart, why didn't you leave out $1 + 2 + 19$ and compute $P = 170,255,085$?"

"Which is only wrong by a billion or so," mocked Cal. "You and Amos have been combining absolute primes, but the profundity of the problem permits powers of primes as well. I vote for $P = 4 \cdot 5 \cdot 7 \cdot 9 \cdot 11 \cdot 13 \cdot 17 \cdot 19 \cdot 23 = 1{,}338{,}557{,}220$, but I can't prove it's the maximum."

"The proof of maximinence may lie in acquiescence," quipped the Professor, "but if there had been 11, 13 or 18 girls, you couldn't ignore a composite like 6. If primitivity had not been implied, the factors would have been 3's and 2's, minimizing the latter, with $P = 3^{36} = 15 \cdot 10^{16}$. Finally, if integers had not been implied, $P = e^{108} = 18 \cdot 10^{46}$.

"Coming back to less exciting fields of engineering, I've been saving a nice problem sent me by Anne Othernut, whom I'll call 'Guest Professor in absentia.' The doctor is keeping Anne home for awhile, so I'll have to read it to you.

"'Dear NeRo: Paul Bunyan's toothpick was the tallest tree he could find—felled, slashed and skinned with a single stroke of his two-bitt axe. It was a perfect cone, 311 ft long, 5 ft at the butt and 50 tons in heft. Moving it to the museum was a delicate operation, achieved by balancing it on two axles so as to minimize bending stresses. How far did the business end of the toothpick overhang the rear axle? This problem is a dilly. Hoping you are the same, LXXX, /s/ Anne.'"

[Cal Klaters were: Flo Ridan (Charles G. Edson), Stream Liner (Julian Hinds), Sauer Doe (Marvin Larson), Richard Jenney and R. E. Philleo. Guest Professor Anne Othernut is J. Charles Rathbun.]

Alaska Road Program Is Geared to Defense Needs

The Alaska road program for 1951 has been planned primarily to meet national defense needs, according to a release from the Alaska Road Commission. Work on roads under construction will be continued, but no new projects have been authorized except those with definite defense significance. Construction of the new Seward-Anchorage Highway, said to be one of the most useful and beautiful roads in the country, will be pushed to completion.

Completion of a new road extending from the Alaska Highway at Tetlin Junction, near Tok, to Eagle, Alaska, and to Dawson in the Yukon Territory will open up much mining country in the old Fortymile and Eagle mining districts. Work will also be continued on a road to connect Mt. McKinley National Park with the main Alaska road system.

Reconstruction and improvement of the main roads, including resurfacing with a blacktop finish, will receive major emphasis. At the end of the 1950 construction season the first 90 miles of the Glenn Highway extending eastward from Anchorage had been hard surfaced, and resurfacing of the entire remaining portion of the highway to Mile 189 at Glennallen is under contract for completion this year. In addition, the Richardson Highway will be resurfaced from Big Timber, at the junction with the Tok Cut-off, southward to the vicinity of Tonsina River, a distance of about 50 miles. With completion of these improvements, it will be possible to drive on a hard-surfaced road from Anchorage over 200 miles in the direction of the United States, by way of Tok, and over 225 miles in the direction of Valdez.

All resurfacing projects and construction of the Seward-Anchorage Highway are being performed cooperatively by the Alaska Road Commission and the Bureau of Public Roads. Some of the other projects will utilize funds of the National Park Service and the Department of National Defense.

Port Newark Improvement Program Is Announced

The Port of New York Authority announces plans for immediate construction of two new cargo buildings and two new wharves on the south side of Port Newark. Estimated to cost about $5,000,000, the project will provide facilities for new port business as well as for tonnage displaced by recent leasing of the former Tidewater Terminal area to the U.S. Air Force.

New Developments in Reinforced Concrete Studied at NYU Seminar

Prestressed concrete, long-span thin-shell concrete arches, and precast concrete construction were the subjects presented to a group of 300 designers, construction engineers and contractors at a recent one-day seminar on new developments in reinforced concrete, sponsored by the College of Engineering at New York University.

Arranged by Dean Thorndike Saville, M. ASCE, and Prof. Robert L. Lewis, Assoc. M. ASCE, chairman of the civil engineering department, the program included a review of the theory and design of prestressed concrete and a motion picture depicting the construction of the Walnut Lane Bridge in Philadelphia, the first prestressed bridge in the United States, by John J. Hogan, M. ASCE, structural engineer of the Portland Cement Association; a display of anchoring and jacking devices for post tensioning; and a laboratory demonstration of loading to failure of prestressed concrete beams. Modern applications of concrete shells and long-span arches to the construction of hangars, auditoriums, pavilions and factories were presented by Charles S. Whitney, M. ASCE, of Ammann & Whitney, and Robert Zaborowski, Jun. M. ASCE, of Roberts & Schaefer. Both lectures were followed by informative movies showing construction methods.

Savings in form work and in scaffolding made possible by precasting many identical reinforced concrete shapes and erecting them in a manner similar to structural steel were explained and illustrated by Capt. Emil H. Praegar, M. ASCE, consulting engineer, and by Roger Corbetta, of the Corbetta Construction Co. Recent applications to factory, apartment and multi-story building construction were illustrated.

NEW IN EDUCATION

A new $600,000 Hydrodynamics Laboratory, first M.I.T. unit to be completed with funds made available during the Institute's recent Development Program, was dedicated June 4 at the opening session of a symposium on Hydrodynamics in Modern Technology at the Massachusetts Institute of Technology. The new laboratory, to be operated by the M.I.T. department of civil and sanitary engineering, "brings to the Institute facilities long considered necessary for basic training as well as for research in the mechanics of liquid flow," according to Arthur T. Ippen, M. ASCE, professor of hydraulics and director of the new laboratory.

* * *

A plan for a liberal education in engineering has been announced by Dr. John R. Dunning, dean of the school of engineering at Columbia University. Thirteen selected liberal arts colleges have entered into an agreement with the Columbia School of Engineering to provide this opportunity for educating professionally trained engineers. A student interested in engineering will have the opportunity to study three years at one of the cooperating liberal arts colleges and two years at Columbia. Completion of the five-year program will result in appropriate bachelors' degrees from both Columbia and the liberal arts college.

* * *

In recognition of the fact "that the construction business has become a highly skilled profession, requiring exact knowledge of materials and engineering fundamentals," the School of Engineering at North Carolina State College has established a construction curriculum leading to a bachelor of science degree in construction. Instituted in 1949 in response to the need for men with an engineering background who are also trained in structural and business essentials of the industry, the course is said to be the only one of its kind in the country. Henry E. Griset, associate professor of civil engineering, heads the program.

* * *

Beginning in September of this year Stevens Institute of Technology will admit men for study leading to the doctor of science degree, according to an announcement from Robert H. Baker, director of the Graduate School. The Graduate School will accept a limited number of carefully selected students for this program which will help meet the national need for men qualified to work at the highest scientific and engineering levels. The newly formed division of applied mechanics with Professor Richard F. Deimel as chairman, is the first which will offer work for this degree, with specialization in dynamics, elasticity, hydrodynamics, and aerodynamics.

Positions Announced

The Engineer Center, Fort Belvoir, Va. Several engineering vacancies are available at the Engineer Center, Fort Belvoir, Va. Positions include engineering draftsmen, Grades GS-6 and GS-7, at $3,450–$3,825 per year; civil engineers, GS-7 through GS-9, at $3,825–$4,600 per year; photogrammetric engineers, GS-5 through GS-9, at $3,100–$4,600 per year; sanitary engineer, GS-7, at $3,825 per year; and surveying and cartographic engineers, GS-5 through GS-9, at $3,100–$4,600 per year. Standard Form 57 may be obtained from any Civil Service Commission or Department of the Army civilian personnel office and should be mailed to the Civilian Personnel Branch, Employee Utilization Section, Building 211, Room 200 A, the Engineer Center, Fort Belvoir, Va.

U.S. Civil Service. Announcement of a Civil Service examination for engineers (Grades GS-9 through GS-12), to fill positions paying yearly salaries of $4,600 to $6,400 in various federal agencies throughout the United States, is made. To qualify, applicants must have a college education, with at least four years of experience. Full information and application forms may be secured from any Civil Service Commission or post office, or the U.S. Civil Service Commission, Washington, D.C.

DECEASED

Lawrence Albert Cline (M. '48) vice-president of the United Concrete Pipe Corp., Los Angeles, Calif., died there on March 21. His age was 58. After receiving a degree from the University of Illinois in 1914, Mr. Cline entered the employ of the Los Angeles contracting firm of Mesmer & Rice. From 1922 to 1938 he engaged in private practice. He subsequently served as president and general manager for the Marbelite Corp. of America, Ltd.; president of the Pacific Union Marbelite Co.; and lieutenant commander in the Navy Civil Engineer Corps. For the past five years he had been affiliated with the United Concrete Pipe Corp.

Fred Coffman (Assoc. M. '23) for several years engineer for the Corps of Engineers, at Norfolk, Va., died on April 5. He was 57. At the start of his career, Mr. Coffman was employed by the U.S. Surveyor in Millard, Tooele, and Juab counties, Utah. From 1916 to 1921 he was associated with the Utah-Idaho Sugar Co., having charge of the construction of a canal system and the installation of a pumping plant at Fielding, Utah. Later he was with the Hammond Canal Co., in Utah, and the Pioneer Gold Dredging Co., at Fairbanks, Alaska. He received his training at Stanford University.

Lincoln Ellsworth (Assoc. M. '11) civil engineer and Arctic and Antarctic explorer of world-wide fame, died at his home in New York, N.Y., on May 26, at the age of 71. Educated at the Sheffield Scientific School and the Columbia University School of Mines, Mr. Ellsworth decided early in life to devote himself to exploration. His explorations included an expedition, under the sponsorship of Johns Hopkins University, to make a geological survey of a cross section of the Andes Mountains from the Pacific Ocean to the head-waters of the Amazon. A pioneer in the air exploration of both polar regions, he laid claim to 377,000 sq miles of new land in the Antarctic for the United States. The many honors awarded him included a special Congressional gold medal for his "conspicuous courage, sagacity, and perseverance on the polar flight of 1925 and transpolar flight of 1926." As a lieutenant commander in the Navy in World War II, he continued his explorations for the United States.

Lincoln Ellsworth

George Robert Graham Conway (M. '07) for many years president of the Mexican Light & Power Co., Mexico, D.F., died recently at the age of 78. Mr. Conway began his career with H. J. Weston, civil engineer of Southampton, England. Subsequently, he was resident engineer for the City of Aberdeen, Scotland; chief engineer and official representative for the Monterrey Water & Sewer Co. and the Monterrey Railway Light & Power Co.; and chief engineer, assistant general manager, and consulting engineer for the British Columbia Electric Railway Co. In 1916 he was engaged by the Mexican Light & Power Co., which he served in various executive capacities until the time of his death.

Charles Henry Davis (M. '95) of Bass River, Cape Cod, Mass., died on June 3, at the age of 86. Upon his graduation from Columbia University, Mr. Davis worked for several electric equipment manufacturers. He established his own consulting practice in 1889, and during his career designed many lighting systems, power and railway plants, buildings, bridges, and roads. He founded the Columbia University School of Highway Engineering and established the Davis Library of Highway Engineering and Transport at the University of Maryland, where he received an honorary doctor of engineering degree.

Clarke Kennerley Harvey (M. '21) since 1945 engineering consultant for the Alle-

(*Continued on page 70*)

Deceased

(*Continued from page 69*)

gheny Conference on Community Development, Pittsburgh, Pa., died there on May 2, at the age of 74. Earlier Mr. Harvey was connected with Harry J. Lewis, Pittsburgh consultant; the Koppers Co., at Pittsburgh; and the U.S. Navy Bureau of Yards & Docks, at Charleston, W.Va. He served as resident engineer in the Bureau of Bridges of the Construction Division for Allegheny County, Pennsylvania, on the construction of the Sixth, Seventh, and Ninth Street bridges over the Allegheny River, and later was advanced to principal assistant engineer, bridge maintenance engineer, and office engineer in the Bureau of Construction.

Joseph Vincent Hogan (M. '35) former president of the Arundel Corp., Baltimore, Md., died June 7, at the age of 65. After graduating from Cornell University in 1908, Mr. Hogan became resident engineer on the New York State Barge Canal at Medina. He was later associated with T. A. Gillespie Co. in New York; the International Steel and Ordnance Corp. in Ohio; and the D. L. Taylor Co. in charge of construction of Dry Dock No. 3 at the Philadelphia Navy Yard. In 1919 when the Arundel Corp. was formed by a combination of several contracting firms, including the Taylor Co., Mr. Hogan was made its chief engineer. He became assistant to the president in 1929 and president in 1934, retiring from active duties in 1940 because of ill health. However, he continued as a director and a member of the executive committee until his death.

Albert Arthur Miller (M. '19) chief engineer for the Missouri Pacific Railroad in St. Louis, Mo., died on March 25, at the age of 71. His earlier experience included work as rodman, assistant engineer, and division engineer for the Baltimore & Ohio Railroad, and chief engineer for the West Coast Co. Mr. Miller became connected with the Missouri Pacific Railroad in 1909, where he served in various engineering posts until his death. He graduated from Ohio State University.

Fabian Sebastian Miller (Assoc. M. '36) since 1950 chief engineer of the utilities of Palo Alto, Calif., died there on May 2. His age was 57. Before joining the city engineering department of Palo Alto in 1925, Mr. Miller was engineer for the Oregon State Highway Commission and the Coos Bay Lumber Co. He directed the operation of the utilities during his tenure as city engineer, until his appointment in 1950 to the newly created post of chief engineer. Mr. Miller began his engineering career with the Alaskan Railroad.

Samuel Murray (M. '18) Portland, Oreg., consultant, died on October 27, 1950, though word of his death has just reached Society Headquarters. He was 70, and a graduate of the University of California. Mr. Murray first worked for the American Bridge Co. and the Southern Pacific Co. He has been bridge engineer and chief engineer of the Oregon-Washington Railway & Navigation Co., and of recent years practiced engineering in Portland. He was a past-president of the Portland Section, which has adopted a resolution honoring him for his service to the Section and to the Society as chairman of the Local Membership Committee. The resolution also cites his work in "location and operation of railroads and in the design of bridges and docks."

George Bigelow Pillsbury (M. '14) former Assistant Chief of Engineers, with headquarters in Washington, D.C., died at his home in Ross, Calif., on May 8, at the age of 75. General Pillsbury was a veteran of over 40 years of service with the Army Engineer Corps. An expert on river and harbor works, he had charge of such projects in San Francisco and Los Angeles, Calif., and New London, Conn. He served with the American Expeditionary Forces during World War I. In 1937 he retired as Assistant Chief of Engineers, with the rank of brigadier general.

General Pillsbury

William Edmund Price (M. '19) for many years head of his own construction company in Oklahoma City, Okla., died there on May 11. He was 67. Prior to engaging in private practice, he was an associate and partner of A. D. Campbell, contractor. Earlier he had worked for the Atchison, Topeka & Santa Fe Railroad; Oklahoma City, Okla.; and Layton & Smith, architects. He received his engineering training at the University of Missouri.

John Reimann (Assoc. M. '26) for the past 27 years special engineer in the valuation department of the Richmond, Fredericksburg & Potomac Railroad Co., Richmond, Va., died on May 10, at the age of 62. He received his education at the Sheffield Scientific School. At the outset of his career, Mr. Reimann was employed by the Missouri Pacific Railway and the Panama, New York Central, and the New York, New Haven & Hartford railroads. He became junior and then senior civil engineer in the Bureau of Valuation of the Interstate Commerce Commission, and from 1924 until his death, he acted as special engineer for the R.F. & P. R.R.

Roderick Edwin Riddle (M. '47) consulting engineer of St. Joseph, Mo., died on April 19. He was 64. Before the organization of his engineering firm in 1945, Mr. Riddle had been connected with the St. Joseph Structural Steel Co. for about 30 years. Earlier he served the Tallahatchie Drainage District and the Kansas City Structural Steel Co. He was a University of Missouri graduate.

Ranbir Singh Shrikant (Jun. M. '48) assistant engineer for the Government of India, at New Delhi, died recently at the age of 28. A graduate of Punjab University, Mr. Shrikant was doing graduate work at Harvard University at the time of his death. At the beginning of his career, he was associated with the agricultural engineer of Punjab, and he was with the Punjab Public Works Department before coming to the United States as an engineering trainee.

Ingvart Teilman (M. '37) retired irrigation engineer of Fresno, Calif., died there on September 27, 1950, though notice of his death has just been received at Society Headquarters. He was 96. During his long career Mr. Teilman had been city engineer of Fresno; engineer for the Madera Sugar Pine Lumber Co.; and irrigation engineer for several canal concerns, including the Consolidated Canal Co., which he served as chief engineer, manager, and director. Entering private business in 1906, Mr. Teilman practiced engineering for over 30 years before retiring.

Carlton Scott Wicker (Assoc. M. '39) sales manager for the Buffalo Slag Co., Inc., Buffalo, N.Y., died there on May 17, at the age of 61. A pioneer in the introduction of slag in concrete for construction purposes, Mr. Wicker joined the Buffalo Slag Co. as sales engineer in 1919 and later was promoted to sales manager. During World War I he served in the 16th Corps of Engineers in France. He attended Dartmouth College.

C. S. Wicker

Oscar Ambrose Zimmerman (M. '40) retired civil engineer of Kansas City, Mo., died May 21, at the age of 69. Mr. Zimmerman was with the Kansas City Bridge Co. as chief engineer, vice-president, and general manager from 1922 to 1939. Later he became connected with the Massman Construction Co., and was assistant to the president of the Doullut & Ewin Construction Co., of Mobile, Ala. He graduated from the University of Kansas.

NEWS OF ENGINEERS

Gordon R. Young, retired engineer commissioner of Washington, D.C., recently received a token of recognition from President Truman—a scroll lauding his accomplishments. The scroll, signed and presented by the President at White House ceremony, read: "In appreciation of the loyalty and integrity which have marked your 5½ years of service to the District of Columbia as engineer commissioner, and in grateful recognition of your persistent effort and wise counsel which have resulted in many civic improvements that will stand as lasting tribute to your energy and engineering genius."

Peter Varvis, until recently engineer for the California State Division of Highways, at Sacramento, is now in the District VII office of the Division in Los Angeles.

(*Continued on page 74*)

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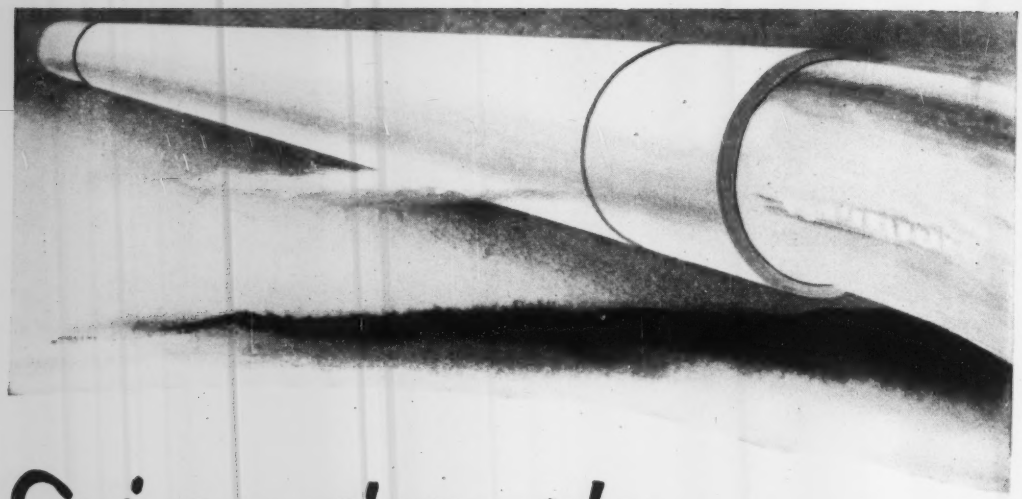

Saving precious water for a thirsty

Municipal consumption of water in the United States has risen from two billion to over twelve billion gallons per day in the last fifty years.

In many areas, this rapid increase is posing a serious problem. It means that water supplies must be conserved to the limit if they are to continue to meet an ever-growing demand.

It is not surprising, therefore, that more and more water-works officials are seeking ways to cut down on water losses as one practical step toward the solution of this problem.

Since recent studies indicate that many localities are losing as much as 10% of water pumped because of underground leakage, an important question to be answered in any water conservation program is this: "How can I plan to reduce this major cause of water loss to a minimum?"

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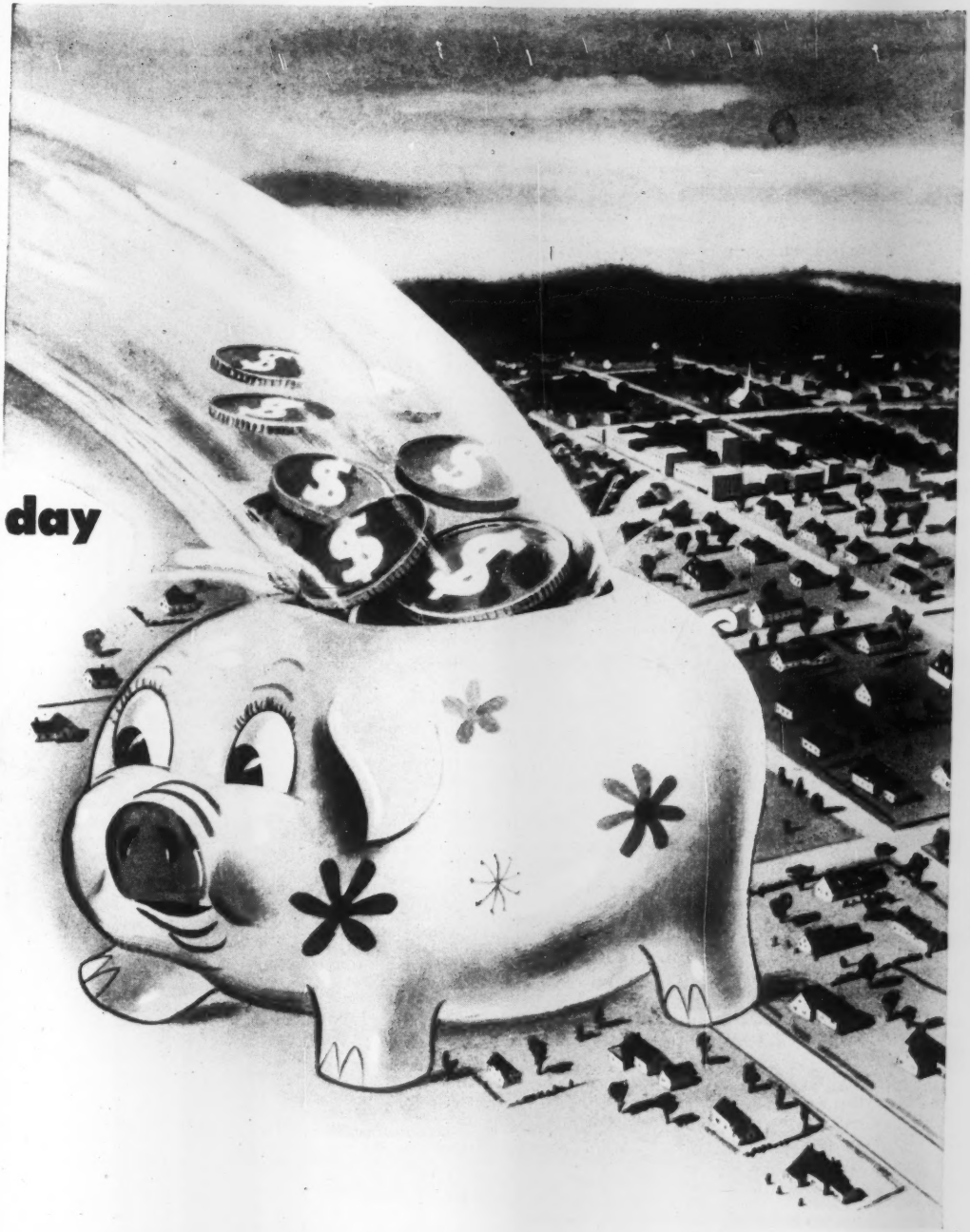

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News of Engineers

(*Continued from page 70*)

John C. Rehfield, associate editor of ASCE Technical Publications, New York City, has been elected treasurer of the Harvard Engineering Society for 1951.

John P. H. Perry is now chief of the Office of Facilities and Services for the Munitions Board, with headquarters in Washington, D.C. The Munitions Board is connected with the office of the Secretary of Defense, and its facilities and services encompass all construction matters coming within the purview of the board. Mr. Perry, who has been associated with the Turner Construction Co. of New York City since 1906, for the past 30 years as vice-president, will continue to serve the company as a director. He is a former President of the Society.

Blackstone Studios, Inc.

J. P. H. Perry

Worth B. Richardson has been transferred from the Muscle Shoals, Tenn., office of the Tennessee Valley Authority, to the Chattanooga office, as construction superintendent in the Construction and Maintenance Branch.

H. E. Pfau, formerly in the employ of the City of New York Bureau of Highways and Sewers, has gone to Casablanca, Morocco, on a U.S. War Department contract held by the Porter-Urquhart Association.

Rudolf P. Forsberg has retired from active consulting engineering practice in Pittsburgh, Pa. He plans to make his residence in Lake Worth, Fla.

Bakir Kashif Alghita, of Baghdad, Iraq, recently received his doctorate in irrigation and drainage engineering from the Utah State Agricultural College.

Winchester E. Reynolds, commissioner of public buildings, Public Buildings Administration, Washington, D.C., recently received honorary membership in the American Institute of Architects.

J. C. Stevens and **R. E. Koon,** consulting engineers of Portland, Oreg., announce that their engineering office is now located in the National Building, 732 S.W. Third Avenue, Portland.

S. W. Schellkopf, of Schenectady, N.Y., has been elected president of the Eastern New York chapter of the American Institute of Architects.

William D. Schwalbe is now associated with the General Motors Corp., as engineer in the plant engineering department of the Pontiac Motor Division, at Pontiac, Mich.

B. L. Robinson was recently appointed by President Truman to the post of engineer commissioner of the District of Columbia. Formerly Colonel Robinson served as South Atlantic District Engineer for the Corps of Engineers, at Atlanta, Ga.

James Donald Carpenter, vice-president of Gannett, Fleming, Corddry & Carpenter, Inc., consulting and contracting engineers of Harrisburg, Pa., was elected president of the Pennsylvania Society of Professional Engineers at the organization's 16th annual convention in Allentown. He has also served the organization as state director and vice-president.

Harold V. Hawkins, formerly professor of civil engineering at the Illinois Institute of Technology, has accepted the position of chief engineer in the aircraft division of the Globe Corp., at Joliet, Ill.

W. E. Lefebvre, for a number of years state highway engineer of Arizona, has resigned to become postmaster of Phoenix. He will be succeeded as highway engineer by **R. C. Perkins.**

S. K. McLelland, chief engineer for the State Highway Commission, at Oklahoma City, Okla., has retired after 35 years of service.

Charles H. Sells, since 1949 executive director of the New York Good Roads Association, has resigned to devote his entire time to his consulting engineering practice in New York City. **William H. Duffy** will succeed Mr. Sells as executive secretary.

Forrest F. Varney, previously with the Naval Ordnance Test Station, China Lake, Calif., has gone to Athens, Greece, where he is an irrigation specialist for the Knappen Tippetts Abbett Engineering Co., of New York, on projects under the Economic Cooperation Administration.

Gerard C. Weeshoff has been named vice-president and manager of the southern California branch of A. Teichert & Son, Inc. He has been on the engineering staff of the company for some time.

William W. Wilson, formerly chief engineer for Moffatt, Nichol & Taylor, at Spokane, Wash., is now a member of the architectural engineering firm of McClure, Adkinson & Wilson, of that city.

W. A. Heindle, for 20 years a member of the Wilmington, Del., public utility commission and the transportation board, was guest of honor at a recent dinner meeting of the Wilmington chapter of Tau Beta Pi. At that time Mr. Heindle received a plaque, commemorating his years of service both to the chapter and to Wilmington.

Donald Hull McCreery, previously president of Quinton Engineers, Ltd., of Los Angeles, Calif., is now director of engineering for Holmes & Narver, Inc., with offices in Los Angeles. Holmes & Narver recently acted as engineering, construction, and management contractor to the Atomic Energy Commission on AEC experiment at Eniwetok Atoll in the central Pacific.

D. H. McCreery

Jack Graham, until recently engineer for the Department of Public Works, at Dallas, Tex., has been appointed assistant to the city manager of Dallas.

Ivan C. Crawford, who retired as dean of the college of engineering of the University of Michigan, on July 1, will join the faculty of the University of Denver College of Engineering at the end of the current academic year. A well known engineering educator, Dean Crawford has served as dean of engineering at three major institutions—the universities of Idaho, Kansas, and Michigan. As a professor of civil engineering at Denver University, he will do some teaching for senior and advanced students, and will conduct a special inquiry into the needs of industry in the Colorado and Rocky Mountain region that can be served by the college. He is a former Director of ASCE.

Ivan C. Crawford

Walter L. Wimer, head of his own architectural-engineering concern in Butler, Pa., announces the opening of an affiliate office at 1926 Sunrise Boulevard, Fort Lauderdale, Fla., in partnership with Charles Foster McKirahan.

J. F. Roberts has accepted an appointment to the position of director of engineering for the Allis-Chalmers Manufacturing Co., in Milwaukee, Wis. Since 1942, Mr. Roberts has been manager of the hydraulics department there.

Drury Butler, North Sacramento, Calif., consultant, has transferred his office to 2115 J Street, Sacramento.

Alvin F. Meyer, command sanitary engineer in the Preventive Medicine Division, Office of the Air Surgeon, Air Materiel Command, at Wright-Patterson Air Force Base, Ohio, has been appointed a member of the Committee on Industrial Sanitation in the Engineering Section of the American Public Health Association.

Roy E. Jorgensen has been made engineering counsel for the National Highway Users Conference, with headquarters in Washington, D.C. Formerly Mr. Jorgensen served as deputy commissioner and chief engineer of the Connecticut Highway Department, at Hartford.

Robert E. Lane, Kern Pratt, Jr., Robert L. Taylor, and **Lonnie M. Nolan,** junior civil engineers for the Humble Oil & Refining Co., in New Orleans, La., have been promoted to associate civil engineers there.

Stewart S. Neff, supervisory engineer and superintendent of construction for the Knoxville Board of Education, Knoxville, Tenn., has been made acting project engineer in the Savannah District of the Corps of Engineers on the new Air Force Base at Knoxville Airport.

(*Continued on page 78*)

3 Types of Paving Built Better with Bitumuls

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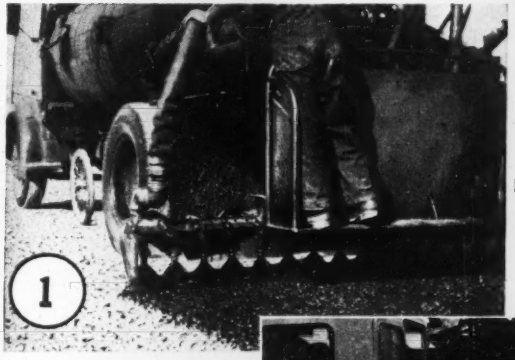

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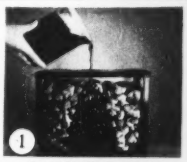
In most highway paving manuals, BITUMULS is a recognized standard for sealing and surface treating. Engineers in Honolulu are no exception—they "shoot" BITUMULS the year 'round.



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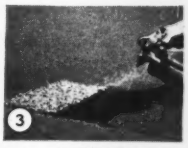

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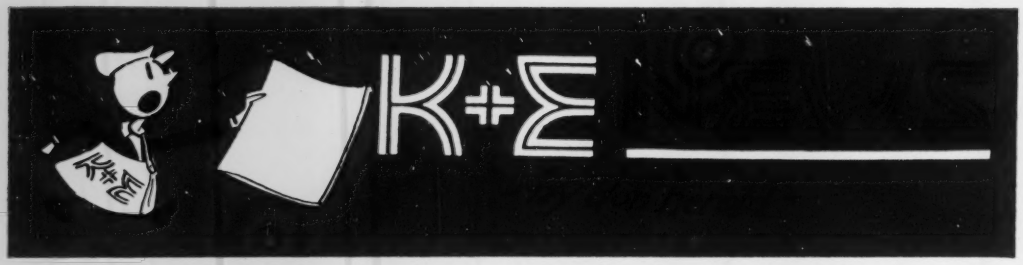

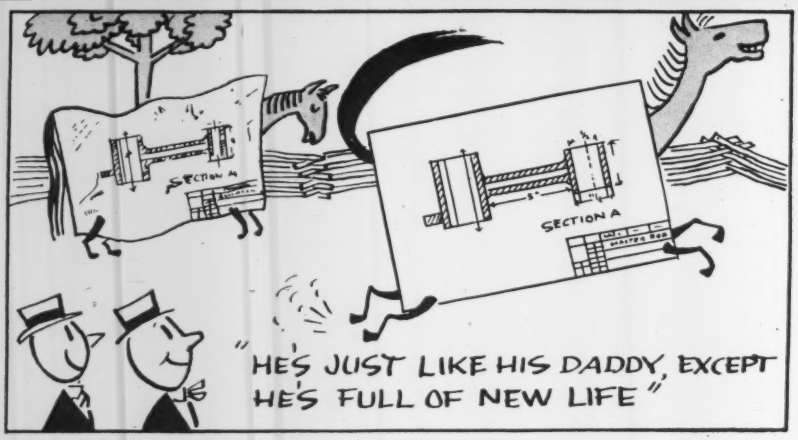

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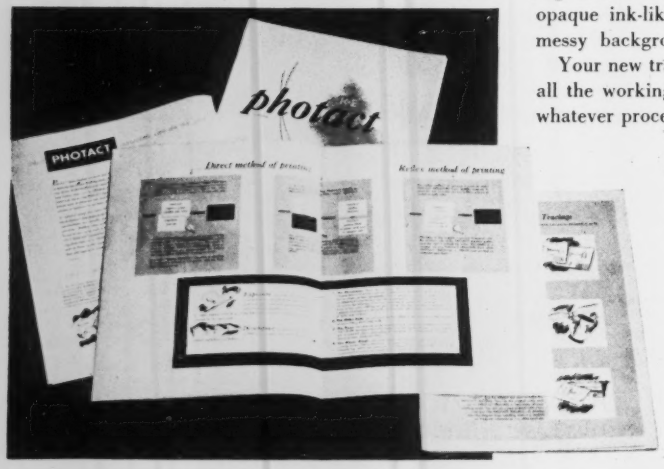

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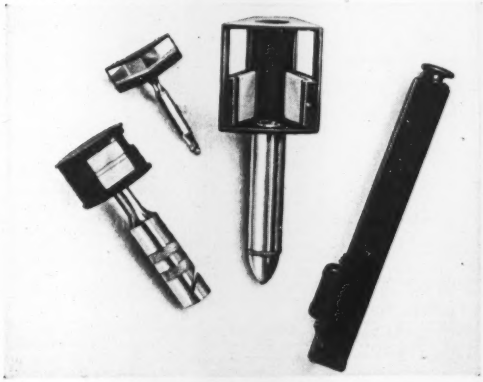

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News of Engineers

(*Continued from page 74*)

Harry F. Blaney, since 1944 research project supervisor for the Soil Conservation Service, at Los Angeles, Calif., was recently cited by the SCS "for unusual and invaluable contribution to Western agriculture by developing a practical method of predicting consumptive water uses under the many varied conditions found throughout the West." Mr. Blaney has been engaged in irrigation research work for the past 35 years.

H. F. Blaney

W. E. Suter, resident engineer for the Texas State Highway Department, at Woodville, recently received his 25-year service star from the department.

Ralph W. Whitaker, Jr., formerly with the State Division of Water Resources, Sacramento, Calif., has become a member of the staff of *Western Construction* (formerly *Western Construction News*), in San Francisco. Mr. Whitaker is a past-president of the ASCE Sacramento Section Junior Forum.

William Zobel, captain, U.S. Navy Civil Engineer Corps, and director of Safety, Office of Industrial Relations, at Arlington, Va., has gone to Ankara, Turkey, on a special assignment.

Edgar E. Foster, hydraulic engineer of Denver, Colo., has gone to Northern Rhodesia, where he will recommend methods of utilizing water resources for irrigation and flood-control purposes.

L. W. Grayson, previously superintendent of the electric light and water section of the Department of Public Utilities, at Riverside, Calif., has been named general manager and chief engineer of the Public Service Department of Glendale, Calif.

Wesley E. Gilbertson, sanitary engineering director and executive officer of the U.S. Public Health Service's Communicable Disease Center, at Atlanta, Ga., recently acted as technical adviser for the United States at the World Health Assembly in Geneva, Switzerland.

George Kumpe, since 1948 with the Munitions Board in Washington, D.C., succeeds **Col. David A. Morris** as district engineer for the Corps of Engineers, at Milwaukee, Wis. **Col. Beverly C. Snow** is now Upper Mississippi Valley Division engineer for the Corps.

Ray Samuelson, engineer in the bridge department of the State Division of Highways, at Sacramento, Calif., has been recalled by the U.S. Navy for active service as a line officer on a destroyer.

Henry T. Lofft has been made project manager on the Tennessee Valley Authority's new Kingston Steam Plant job. **A. H. Weber,** project manager on the Hales Bar Dam, at Chattanooga, has been promoted to project manager on the Widows Creek Steam Plant, at Stevenson, Ala., succeeding Mr. Lofft. **William W. Aydelott,** formerly resident engineer for Ebasco Services, Inc., at Jackson, Miss., has become assistant construction engineer at the Widows Creek Steam Plant.

Albert B. Goodwin, associate hydraulic engineer in the Water Resources Branch of the U.S. Geological Survey, at Asheville, N.C., and **Herbert F. Finck,** superintendent of power and water for the Ecusta Paper Corp., at Pisgah Forest, N.C., were recently installed as directors of the Engineers Club of Western North Carolina.

Vaud E. Larson, for the past five years assistant regional planning engineer for the U.S. Bureau of Reclamation, at Phoenix, Ariz., has been named head of the Bureau's Region 3, Branch of Project Planning, at Boulder City, Nev. In this capacity Mr. Larson will supervise the investigations for potential irrigation and reclamation developments in southern California and Nevada and various parts of Arizona, Utah, and New Mexico.

Vaud E. Larson

William P. Kelleghan, who has been employed by Stewart Associates, Inc., Cambridge, Mass., has become structural engineer for the Carbide & Carbon Chemical Co., at Oak Ridge, Tenn.

W. H. Campen, president and manager of the Omaha Testing Laboratories, at Omaha, Nebr., has been engaged by Douglas County, Nebraska, as part-time consultant.

F. N. Hveem, who has been construction engineer for the California Division of Highways, at Sacramento, has been made materials and research engineer there. He succeeds **Thomas E. Stanton,** who has retired after 39 years of service.

Howard S. Ives, since 1950 head of the east district of the Connecticut State Highway Commission, at North Stonington, has been appointed coordinating district engineer.

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Meetings and Conferences

American Institute of Electrical Engineers. Headquarters for the Pacific general meeting of the American Institute of Electrical Engineers will be the Multnomah Hotel, Portland, Oreg., August 20–23.

American Public Works Association. Problems resulting from the Controlled Materials Plan will be discussed at the public works congress and equipment show, sponsored by the American Public Works Association, in the Veterans' Memorial Building, Detroit, Mich., September 16–19.

Conference on Prestressed Concrete. The Conference on Prestressed Concrete will be held at the Massachusetts Institute of Technology, August 14–16. Co-sponsors are the American Concrete Institute, American Institute of Architects, American Railway Engineering Association, American Society of Civil Engineers, Associated General Contractors of America, and the Portland Cement Association. Further information and registration forms may be obtained from Prof. Myle J. Holley, Jr., Department of Civil Engineering, Room 1-230, Massachusetts Institute of Technology, Cambridge 39, Mass.

Society of Automotive Engineers, Inc. The West Coast meeting of the Society of Automotive Engineers, Inc., is scheduled for the Olympic Hotel, in Seattle, Wash., August 13–15.

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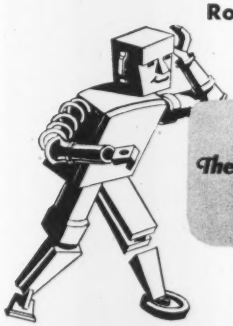

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CLEAVES, ARTHUR BAILEY, St. Louis, Mo.
DOWNING, LEWIS KING, Washington, D.C.
GABRIELSON, EDWARD FRANCIS GUNNAR, San Diego, Calif.
GROEN, MICHAEL ALOYSIUS, Dearborn, Mich.
HUDSON, HARRY LEROY, Oak Ridge, Tenn.
HUTCHESON, THOMAS BARKSDALE, Norfolk, Va.
JENNINGS, WILLIAM SAMUEL, Richmond, Va.
LINDSTROM, JOHN M., Elmhurst, Ill.
LIU, JU-SUNG, Taiwan, China
MALONEY, JOHN MONAS, Gary, Ind.
MCKEE, ALBERT REED, San Diego, Calif.
RAY, OSCAR BRYANT, Vicksburg, Miss.
SEIDEL, IRWIN LOUIS, Cleveland, Ohio
SIMONSON, JOHN CARL, Oklahoma City, Okla.
SIVERTS, JOHN SMITH, Oak Ridge, Tenn.

Applying for Associate Member

ARNOLD, RUSSELL ELLSWORTH, Glendale, Calif.
BISSELL, CHARLES NEWTON, Centredale, R.I.
BOYACIOGLU, MUSTAFA ATIF, Salt Lake City, Utah
CARRINGTON, ROBERT BERNARD, JR., South Miami, Fla.
DOWD, MUNSON WHITE, Altadena, Calif.
GRAZIANO, JOSEPH JOHN, North Bergen, N.J.
HIRSHIK, PHILLIP SIDNEY, Los Angeles, Calif.
LOEWER, ALVIN CONRAD, JR., Bethlehem, Pa.
LUCOFF, JULIUS, Seattle, Wash.
MCNULTY, JAMES FRANCIS, Hampton, Va.
MEYER, RUDOLPH WILLIAM, St. Louis, Mo.
SEFTON, WOLF, Cheshire, England
SESSUMS, FRANCIS BLAKE, Bismarck, N. Dak.
SNYDER, THOMAS PHILLIP, Leesville, La.
SPANGLER, BYRON DEMENT, Gainesville, Fla.
STARMANS, GEORGE ADOLPHE NICHOLAS, Nyasaland, Africa
VEY, EBENEZER, Chicago, Ill.
WAGNER, ELDON CHRISTIAN, Madison, Wis.
WRIGHT, FRANK VERNON, JR., Topsham, Me.
ZIMPFER, WALTER HENRY, Gainesville, Fla.

Applying for Junior Member

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CIRLOS, LEONIDES LOPEZ, Oklahoma City, Okla.
DIACHISHIN, ALEXANDER NICHOLAS, New York, N.Y.
DODD, ROBERT LESTER, Baltimore, Md.
ECK, CHARLES EDWARD, Brentwood, Mo.
FERNANDEZ, DIEGO FERRER, Caracas, Venezuela
JACOBS, ALVIS WAYNE, Wyandotte, Mich.
LOMBROZO, NATHAN, Arlington, Va.
PETERSON, ENOCH WESLEY FROST, Denver, Colo.
PHILIP, JOHN ROBERT, Queensland, Australia
TRUNEM, BERNARD ROY, Seattle, Wash.

UNIV. OF ALABAMA

Wamsley, Robert Martin

ALABAMA POL. INST.

Paxton, William Morrison, Jr.

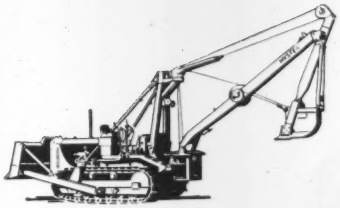
UNIV. OF ALASKA

Letcher, Alfred
Lewison, Edward William
Martin, George Sam, Jr.
Reebs, Louis Lee

UNIV. OF ARIZONA

Adams, Joseph Theodore
Anderson, Roger Dean
Attebery, James Edward
Burkhardt, Richard Aloysius
Bush, Glenn Clifford
Chrisman, Leon Joe
Coy, Tommy Ray
Ewing, Robert Nathan
Firth, Charles Richard
Folkerts, Wendell Henry
Holderby, William Thomas
Kelly, Fred G.
Lamb, Basil Jack
Lamb, Burnie Mack
Legters, George Ralph, Jr.
Levario, Florencio Lozano
LoPresti, Frank Emanuel
Nelson, Stanley Theodore, Jr.
Redden, Melvin Lawrence
Roper, David Herbert
Russell, Richard Kenneth
Shannon, John Hubert
Steinheimer, David Lee
Stevens, Felix Robert
Struthers, Burton Arthur
Titus, Joseph Parker, Jr.
Valentine, Harry Jones, Jr.
Webb, Phillip Thomas

(Continued on page 84)



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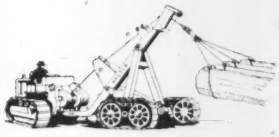
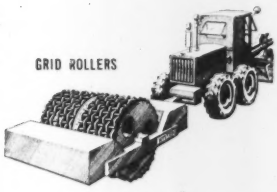


LOGGING ARCHES
AND SULKIES



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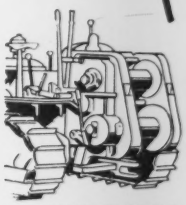

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CIVIL OR SANITARY ENGINEER with 2 or more years' experience in the design of municipal and industrial sanitary engineering projects. Salary dependent on qualifications. State salary desired. Location, Ohio. Y-5315.

CIVIL ENGINEER for design work on park and parkway development; 5 years general design experience in minor structures, utilities, and roads, with some field experience desired. Location, Michigan. Y-5316.

FIELD ENGINEER, civil graduate, with considerable cement aggregate and general concrete testing experience, to be responsible for selection of ingredients, preparation, mixing and placing concrete form set-up and reinforcement. Salary, $7,800 a year, including subsistence and quarters. Location, eastern Canada. Y-5335.

CIVIL ENGINEER, graduate, with 3 years' experience in construction work for a sugar mill. Salary open. Location, Puerto Rico. Y-5441.

CIVIL ENGINEERS, graduates; with some knowledge of structures, for construction safety engineering department of insurance company. Salaries, for recent graduates, under 26, single, $2,850 a year to start; over 26 with experience, $3,000–$4,100 a year; increments every 6 months for first 2 years. Location, New York, N.Y. Y-5463.

WATER WORKS SUPERINTENDENT to take charge of operations of municipal water pumping station and treating plant. Salary, $8,400 a year. Location, Ecuador. Y-5486.

SALES ENGINEER, 30–40, electrical, civil or mechanical degree, experienced in sales work in the electrical field, with knowledge of a foreign language, for manufacturer of wire, rods, and strands used by utilities, telephone systems, and railroads. Considerable traveling. Territory, eastern or mid-central United States with headquarters in Pennsylvania. Y-5494.

CIVIL ENGINEER, young, with 2 to 3 years' experience on construction, preferably having some estimating experience, for valuation work of all types of buildings and structural knowledge of such buildings in order to properly inspect them from a structural-insurance standpoint. Location, New York, N.Y. Y-5502.

PLANNING AND ENGINEER ASSISTANT, 22–42, with basic knowledge of surveying and civil engineering methods, to perform surveying, drafting, and other engineering work in connection with public works construction, including setting of grades and preparation of plans, profiles, and specifications; to inspect public works construction in process for conformity to specifications and pertinent town regulations. Location, Connecticut. Y-5530.

CONSTRUCTION ENGINEER, 26–35, civil graduate, with field experience in concrete, to act as sales and service engineer for large cement company. Salary, $3,600–$4,800 a year. Training period in Pennsylvania. Various locations in eastern and southern states available. Y-5555.

SALES ENGINEERS. (*a*) District Sales Manager, civil engineering degree, for large manufacturing concern in construction materials. Must have had experience in contacting engineers and contractors and be a resident of the South. Excellent opportunity. Salary open. Location Georgia. (*b*) Sales Engineers, 24–40, graduate civil engineers, with some sales experience, to represent above company. Territories, Atlanta, Ga., and Decatur, Ala., and their vicinities. Prefer applicants from the South. Salary open. Y-5566.

ROADMASTER with engineering background and thoroughly experienced, for 200 miles of railroad that employs 30 section and 3 bridge gangs. All bridges O.D. pile trestle type and number into the hundreds in rough and hilly country. Must have a fair knowledge of Spanish. Salary open. Location, Central America. Y-5581.

GRADUATE ASSISTANTS in civil engineering, for research work in any one of the following: Study of hydraulic design of inlet-type grate; hydrologic study of factors influencing rainfall-runoff relationships on small watersheds, variation in amount of frost heave with depth of groundwater table, effect of washed concrete sand in increasing capillary rise and frost heaving in adjacent soil, capillary potential of various materials, filter tests of various materials, measurement of earth pressures against retaining walls, and study of concrete reinforcement with electric strain gage. Will spend half of time in graduate work making it possible to secure master's degree in 2 years. Salary, $1,740 a year. Location, Connecticut. Y-5593.

ASSISTANT EDITOR with 4 or 5 years' experience on construction publications. Must be able to turn out top-notch original copy and handle rewrite work. Field experience in construction engineering background desirable. Salary, $4,500–$5,000 a year. Location, New York, N.Y. Y-5609.

STAFF ENGINEER, chemical or civil; 35; 5 to 10 years' experience on chemical plant design, layout of plant and equipment for manufacture of phosphate. Be in complete charge of initial design and later follow through on construction and installation of equipment. Must know phosphate problems thoroughly and be able to determine type of process to use to convert phosphate to chemical fertilizer. Salary, $15,000. Location, headquarters in Chicago. R-7834.

ASSISTANT TO PRESIDENT, mechanical or civil engineer; 38; experienced in solving operating problems. Knowledge of foundry operations helpful. Duties: Assist president on foundry and branch operating problems and their solution. Will be trained in foundry operations. Salary $6,500–$7,500 a year. Location, Chicago and Illinois. R-7786.

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ASCE Applications

(Continued from page 80)

UNIV. OF CALIFORNIA
Aitchison, Robert Gordon
Beck, James Winfield
Bernadsky, Alec Eugene
Gardner, George Washington
Moore, John Donovan
Ripley, Peter Marshall
Soo, Alfred Yuen

CASE INST. TECH
Chacos, Gregory
Day, Raymond Arthur
Dingman, Robert Eugene
Dunn, James Thompson
Fox, Frederick King
Herzog, Hans Steffen
Hoffman, William W.
Kearns, Warren Kenneth
Kim, John Wan Hai
Moyer, Donald Weichel
Peterka, Richard August
Plazibat, John Adam
Reese, Richard Davis
Roberts, Eugene Edward
Walling, Richard Lee
Wilson, Marvin Winston

COLUMBIA UNIV.
Gustafson, Gustave John

COOPER UNION
Adam, George Frederick
Bass, Donald
Feldman, Norman
Frank, Arthur M.
Laster, Leon Joel
Robinson, Arthur Richard
Sackman, Jerome Leo
Wenke, Harry Norman

GEORGE WASHINGTON UNIV.
Altshuler, Eugene
Barrasso, Joseph Alfonso
Younger, Edward Francis, Jr.

GEORGIA INST. TECH
Franco, Aaron Morris

ILLINOIS INST. TECH
Halter, Charles Daniel, Jr.

UNIV. OF ILLINOIS
Chang, Rodney Kam Jan

IOWA STATE COLL.
Davis, Weldon Wallace
Hesling, John William
Junko, John Clair
Lum, James
Pronske, Kurt Norwood
Schmitz, Robert Michael
Scholer, Darrel Gene
Swale, Albert Roy, Jr.

UNIV. OF KENTUCKY
Boggs, George B.
Deen, Robert Curba
Goodwin, William Albert
Grubbs, Warner Clifton
Van Winkle, Charles Arthur

LOUISIANA POL. INST.
Deal, Kenneth Edward
Hays, Roscoe Freeman
Johnson, Chester Forrest, Jr.
Kincaid, Charles Gordon
Taylor, George Minor, Jr.
Westbrook, William
Wilson, Herbert Rogers

UNIV. OF MAINE
Hirsch, Norman Winston

UNIV. OF MASSACHUSETTS
Brown, David Lyle
Caton, Edward Maynard, Jr.
Chapdelaine, Edward Norman
Cheneas, George
Dinola, Doming John
Larsen, Robert Samuel

MICHIGAN COLL. OF MIN. & TECH.
Holstad, Louis Chris

UNIV. OF MICHIGAN
Crane, Donald Eugene
Dulbs, Richard Orland
Hulbchen, Harry John
Sundin, John Robert

MICHIGAN STATE COLL.
Kiczenski, Edward Louis

MISSISSIPPI STATE COLL.
Anderson, John Lavelle
Barker, Harold Glen
Bozone, Jesse Carl
Buescher, Francis Aloysius
Byrd, Knollis Edward, Jr.
Filgo, Charles Harold
Fitzsimons, Andrew Jackson, Jr.
Flint, James Robert, Jr.
Godbold, Samuel Davis
Graves, Bishop Bascom, Jr.
Hicks, Alfred Barrett
Hodum, Berl Lathanual
Huff, Perry Landin
Lemmons, Jack Walter
Losset, Joseph Henry
Mansell, James Robert
Mitchell, Charles Henry
Mott, John James
Prince, John Randolph, Jr.
Sanders, James Robert, Jr.
Scott, Jack Dortch
Stephens, Bryan Hale, Jr.
Ulery, Harry Hugh, Jr.
Van Brocklin, Finley Gwinn
Walker, William Elwood
Wells, William Lamar

NEW YORK UNIV.
Fabris, Zromimr Robert
Puglisi, Salvatore

OKLAHOMA A. & M. COLL.
Barker, Horace Max
Breisch, William Bayley
Steinberg, Hyman
Van Den Broeder, F. C. M., Jr.
Wilhelm, John August
Wonderly, Harold Lynn

UNIV. OF OKLAHOMA
Birbilis, Tom Theodore

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Connell, George William
Ryder, Robert Arnold
Scheefe, Paul Wermuth
Schneebeli, Robert Emil

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Brownell, Everett Flagler
Fishman, Herbert B.
Mitchell, James Kenneth
Ramsdell, Robert Reed
Richards, Donald Frank

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Fistler, Merle Levi
Strauss, Werner
Talkington, Howard Ramon

SOUTHERN METHODIST UNIV.
Butler, Horace, Jr.

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Austin, John Henry
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Cunningham, John Raymond
Givens, James Richard
Hamilton, Dalton Earl
Heflin, James Taylor
Kuhn, Howard A., Jr.
McElya, Hal Martin
Miller, Jack Arthur
Newman, John Richard
Pope, William Melvin
Ramer, Joseph Paul
Shouse, Florian Ralph
Shuck, Weldon Rudelle
Staley, Robert William
Stewart, Billy Ray
Swart, Charles Robert

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Corwin, Frederick Alan

TULANE UNIV.
Jackson, Frank Joseph

VILLANOVA COLL.
Egan, John Francis
Hemler, Charles Edward
Lewis, Edward Richard

UNIV. OF WASHINGTON
Anderson, Donald Richard
Brown, Daniel Harvey, Jr.
Bryant, Walter Winfield
Coffelt, Alfred Junior
Cummins, Robert Lyle
Dick, Roland Shaw, Jr.
Drawsky, Ronald Harris
Fan, Tau Chao
Floodeen, Eldon Rodney
Gordon, Clarence Robert
Habel, John Scott
Jasper, Jack Wilbur
Lee, Harold Chock
Luther, Frederick Dean
Matthiesen, Ralph Boyd
Miller, William MacKay
Nessly, Harry Sexton
Peterson, Jack
Porter, Boyd Harris
Smith, David Frederick
Swenson, Donald Keith
Taft, Wesley Edward
Tokola, Alpo John
Weber, Russell Carlton
Wells, Jack Dean
Wendt, Richard Maurice

UNIV. OF WYOMING
Bratzler, Glen Eugene
Chocas, Gust
Foreman, Alfred S.
Gregory, Clinton Charles
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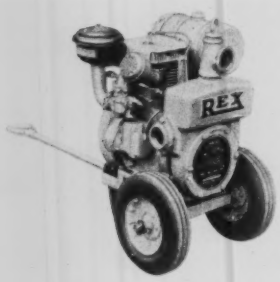
Self Priming Centrifugal Pumps

A LINE OF SELF-PRIMING centrifugal pumps ranging in size from the small $1^1/_2$ in. Model 4M pump up to the 6 in. Model 90M pump has been placed on the market. Capacities of these sizes range from 4,000 gph up to 90,000 gph. The Rex pump is

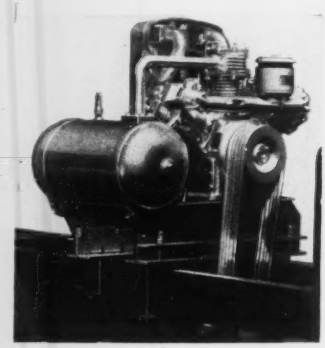


Rex Portable Pump

designed for easy and inexpensive replacement of wearing parts. Removal of the easy-to-get-at cover plate makes it possible to replace or adjust practically all the wearing parts in the pump. The patented high carbon steel air peeler and the open type impeller assure maximum water handling ability. When abrasive wear on peeler or impeller destroys original clearances and pump priming—new pump efficiency can be easily and quickly restored by adjusting the peeler to original tolerance with the impeller. An outstanding feature of the Rex pump is the impeller shaft seal. This seal is never subjected to pumping pressure with the result that considerably longer seal life and more trouble-free pump operation is obtained. Ask for Bulletin 51-27 **Chain Belt Company, 1600 West Bruce St., Milwaukee 4, Wis.**

Compressor

THE MODEL 125 COMPRESSOR now available for truck mounting and truck engine drive will be of special interest to companies whose service and work crews use air tools. The unit mounts on any of five popular makes of $1^1/_2$ and 2-ton rated trucks, adapts to special body designs, and derives power from the truck engine through a simple, rugged power-takeoff.



Truck-Mounted Compressor

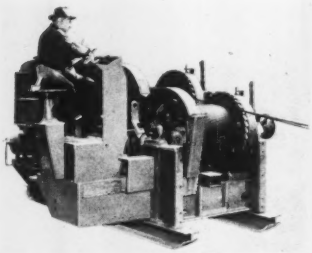
Many advantages over trailer-type units of like capacity are being pointed out to compressor users whose crews use air tools requiring 100-lb air for driving pavement breakers, clay spades, backfill tampers, etc. First costs are lower because there is no compressor engine and engine cooling system to buy; no engine-to-compressor clutch, trailer unit, fuel tank, battery, or towing hitch. Maintenance is halved because there's no separate compressor engine and clutch; no trailer tires to wear, trailer running gear to lubricate, compressor battery to replace, or compressor engine cooling system to guard against freezing. Operating advantages are many. The compressor is Jaeger's new standard model, furnishing 125 cfm of 100-lb air. It is capable of driving two heavy duty, or three medium duty, pavement breakers at full 90-pressure at the tools. The power-takeoff unit takes the place of a part of the truck's drive shaft, contains no gears and has an extremely simple, solid-shaft-type clutch for directing power to the compressor through V-belts, or to the truck's rear wheels. Two simple levers in the truck cab control all functions. During compressor operation, truck engine speed is automatically regulated for idling (unloading) and compressing. Compressing speed is an economical 1750 rpm., approximately 24 mph on the speedometer. **The Jaeger Machine Company, Columbus 16, Ohio**

Conveyor

SPEED IS ONE OF the many features of the light weight troughed belt conveyors that introduce a complete line of portable conveyors designed especially for the construction field. Model 666, handles 75 yds of sand or gravel per hour. This rugged "time saver" also handles ore, lime, cinders—virtually every type of material handling job. Standard construction means a lifetime of maintenance-free operation. Standard equipment consists of a twin hydraulic boom hoist, underslung axle, slide trough, and a 14 in. 4-ply belt. Lengths from 14 ft to 25 ft are available. **The Fairfield Engineering Company, Portable Division, Marion, Ohio.**

Hoist

A HOIST DESIGNED SPECIFICALLY for steel erection has been announced. Called the Iron Workers' Special, the hoist incorporates features specified by steel erectors and hoist engineers from the industry. Of prime importance in hoists used for steel erection is positive load control. The Iron Workers' Special through a torque converter, antifriction bearings, and air operated, contracting type tandem band clutches permit an operator to "feel" his



Iron Worker's Special

load into position accurately and smoothly. Brake linkage between foot pedals and contracting bands is anti-friction bearing mounted for easy operation. Safety features include a back-up brake that engages automatically on reversal of the drive shaft, ratchet rings of forged steel with compression type dogs and overload regulating air valves which permit clutch slippage in case loads become "snagged" or "hung up" while being hoisted. Controls are located on a centralized stand. The stand is rotable and raised high enough to allow operator to watch drums at all times. Basically the Iron Workers' Special is a two drum hoist. A third drum and derrick swinger can be added if desired. **American Hoist & Derrick Co., St. Paul 1, Minn.**

Equipment, Materials & Methods (Continued)

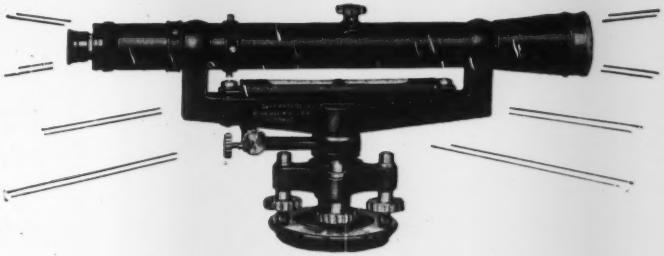
Power Tool

THE MODEL 450 STUD DRIVER is the first cartridge-powered industrial tool to be designed and developed by a manufacturer of sporting arms and ammunition. Weighing little more than five lbs, the cartridge-powered tool can be easily operated by one man and its high degree of portability and efficiency is of particular interest to the general contracting, maintenance, electrical contracting, plumbing contracting and ship fitting fields. The tool can be comfortably operated at a sustained speed of five or more stud settings a minute in concrete, steel, wood, brick, asbestos siding and roofing and other structural materials. The studs are usually employed for the purpose of joining these materials or attaching fixtures to these surfaces. Speed in its use can be stepped up to from 5 to 50 times as fast as other stud setting methods.

Model 450

The secret of the tool's efficiency lies in the unique system of controlling and directing the great energy generated by the small charge of specially developed powder. The "energy supplier" is a 32 caliber Long rim fire blank cartridge. A colored plastic heel cap or cup is inserted in the mouth of the cartridge case. The color indicates the powder load, varying in accordance with the job intended. The studs used vary in length from $^{5}/_{8}$ to 2-$^{3}/_{4}$ in. long and are made of specially developed steel alloy. These studs, which are almost file-hard, will resist shattering when driven. This is accomplished by a carefully controlled heat treating process. The studs are produced in 20 different sizes in four general types: standard head, break-off head, for semi-flush mounting, externally threaded and internally threaded. Interesting features of the tool are its exceedingly low recoil, lack of explosive noise and a firing pin indicator that reveals instantly to the operator that the gun is or is not cocked. One of the outstanding features is its portability. The tool operates completely independent of outside power sources, which eliminates the necessity for investing in such activating forces as air compressors or electric generators and the personnel to operate them. **Remington Arms Company, Inc., Public Relations Div., Bridgeport, Conn.**

When Requesting Product Information Please Mention Civil Engineering



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Look at the chart of important engineering and construction features of the David White 18" Dumpy Level given below. Compare those features, item for item, with every other recognized make of instrument. Then compare prices. You'll see why we say David White 18" Dumpy Levels give you more quality, more advantages important to you in your work for less money. See your nearest David White dealer for complete details on this and other equally fine engineering instruments or write direct to David White Co., 359 W. Court St., Milwaukee 3, Wisconsin.

Features	D. White No. 7080	Instrument A	Instrument B
Magnifying Power of Telescope	35X	30X	27X
Distance away you can read 1/100 ft. graduation	1200 ft.	1050 ft.	900 ft.
Diameter of objective lens	1.81 in.	1.485 in.	1.69 in.
Field of view (In minutes of arc)	64′	52′	60′
Coated optics	YES	YES	YES
Covered Leveling Screws	YES	YES	YES
Can you easily replace worn leveling screws in the field?	YES	NO	YES
Sensitivity of level vial (in seconds of arc per 2mm of graduation)	20″	20″	25″
Price — Complete with carrying case, tripod and accessories — F.O.B. factory	$280.00	higher	higher

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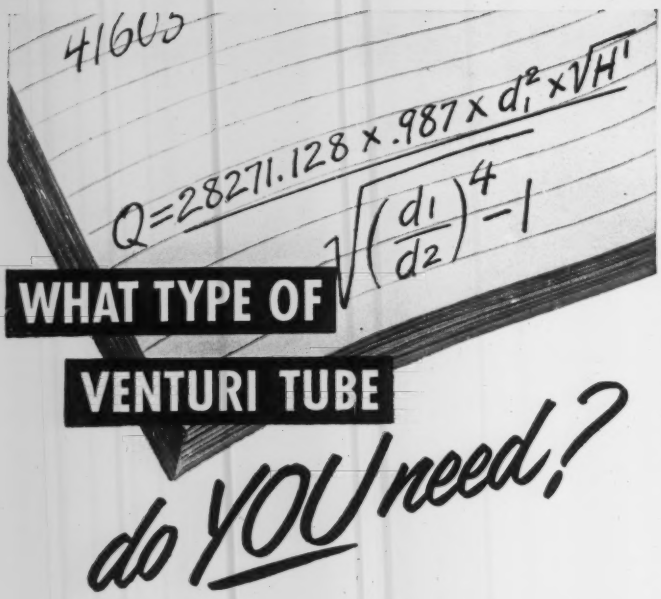

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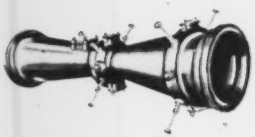
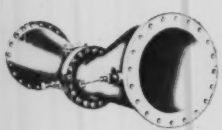
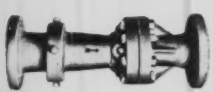
2. Cast iron Venturi Tube with hand holes and cleaning valves at main and throat sections, for municipal sewage and trade wastes.





3. Cast iron Venturi Tube with flat invert and single cleaning valve at main and throat sections. Specifically used for sludge.



4. Cast steel or cast iron Venturi for hot or cold water and adaptable for boiler feed high pressure service.

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These tubes come in many sizes and different designs, some of which are pictured above. This means there's a particular tube to fit specific needs.

Write, stating your Venturi Tube requirements, to Simplex Valve & Meter Company, Dept. 7, 6724 Upland Street, Philadelphia 42, Pa.

SIMPLEX

VALVE AND METER COMPANY

Equipment, Materials & Methods (Continued)

Concrete Saw

EQUIPPED WITH A RELIABLE gasoline motor, the Creeper concrete cutting saw is not dependent on any outside source of power. Engineered to function indoors and out, regardless of job conditions or material being cut, its operation and transportation are a one man job. Guide rails on the Creeper guarantee a smooth edged, straight cut and eliminate cutting blade breakage generally caused by side to side wobble or the application of off center pressure. An integral part of the machine, these guide rails not only improve performance and save blades but facilitate moving the unit from job to job and on the job. Over-all simplification of design has eliminated excess weight, lowered cost and made operation easier. The unit comes complete with a simple water hose attachment. This is for use with diamond or specially bonded abrasive blades where dust suppression is required. Inexpensive abrasive blades are also available from the company for dry cutting all types of concrete, asphalt or masonry. The Creeper easily removes worn, broken or unwanted sections of poured concrete and quickly gets to buried conduit to make emergency repairs. It cuts machine foundations, expansion joints, safety grips or conduit channels with strong clean edges. Where necessary, this allows positive jointing of replacement work and eliminates crumbling or cracking due to overlap. **Martin Fireproofing Corp., P. O. Box 27, Kenmore Station, Buffalo 17, N.Y.**

Diesel Engines

TWO INDUSTRIAL DIESEL ENGINES, the D337 and D326, are scheduled for production. The six-cylinder D337 engine is an industrial version of the 5½ in. × 6 in. engine developed as a power source for the DW20 and DW21 tractors. The D326, although quite similar in design, will be offered with a lower horsepower range. One feature on the two models is the fuel system with fuel pumps mounted adjacent to the cylinders they serve. This results in standard, identical, short fuel lines for each cylinder. Oil cooled pistons have long been standard on "Cat" engines, but a new arrangement has been used on the D337 and D326. The pistons, which have an iron band cast integrally for the upper ring, are cooled by an oil stream sprayed from a nozzle that is solidly attached to the engine block. Since this spray lubricates the piston pin, as well as cooling the piston, oil grooves are not required in the connecting rod. A completely redesigned 25 hp vertical gasoline starting engine is used with the engines. The starting engine has several design features to provide easier starting, regardless of weather conditions. These include crank throws located adjacent to each other to give an even firing design, an up-draft carburetor to provide easier hot starting, as well as excellent cold starting, and a wet type clutch to provide longer life with less adjustment. **Caterpillar Tractor Co., Peoria 8, Ill.**

A section of the drafting room . . . International Business Machines Corporation, Endicott, New York

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Project PR-3

Government of Puerto Rico
Department of the Interior
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Santurce, P. R.

Date: May 15, 1951

ADVERTISEMENT

Sealed proposal will be received by the Commissioner of the Interior of Puerto Rico, at the office of the Board of Awards, Department of the Interior, Santurce, Puerto Rico, until 2:00 P.M. on *September 14, 1951*, and then be publicly opened and read aloud, for furnishing all plant, labor, and materials and performing all work required for the *CONSTRUCTION OF THE GENERAL DISTRICT HOSPITAL BUILDING, PONCE HOSPITAL CENTER, PONCE, PUERTO RICO.*

Plans, specifications, and all pertinent contract documents may be obtained at:

1. **Board of Awards, Department of the Interior, Santurce, Puerto Rico**
2. **Office of Isadore Rosenfield, Architect, 23 West 47th Street, New York 19, N. Y.**

from the date of this advertisement until (15) calendar days before the date for opening bids, upon deposit in cash, money order, or certified check payable to the Commissioner of the Interior of Puerto Rico in the amount of *TWO HUNDRED FIFTY DOLLARS ($250.00).*

The full amount of this deposit will be refunded to the depositor upon return of the above documents in good condition within a period of *THIRTY (30) DAYS* after the date of the opening of bids.

Each proposal must be accompanied by a provisional bond in cash, bid bond, or certified check payable to the Commissioner of the Interior of Puerto Rico for not less than SIXTY THOUSAND DOLLARS ($60,000.00).

Special attention is called to the bidders that any bid which does not contain the prices written in letters and figures will be rejected, and that the Board of Awards reserves the right to reject any or all bids and to waive informalities.

Engineer's Estimate $3,000,000.00.

JORGE J. JIMENEZ
Commissioner

Equipment, Materials & Methods (Continued)

2-Wheel Scraper

A 2-WHEEL, HYDRAULICALLY-controlled scraper for use with the John Deere "R" diesel tractor is announced. The Model H-62, is a 6-yd scraper and will work at speeds up to 12 mph. A special hitch, mounted under the tractor rear axle, eliminates the front wheels of the scraper and transfers a portion of the scraper load to the tractor driving wheels for greater

Model H-61

pulling power. This combination of "R" wheel tractor and ATECO H-62 scraper is in effect a self-propelled scraper that digs, carries and spreads. It is self-loading and self-spreading; no pusher tractor or extra leveling equipment is required. Big pneumatic tires on the tractor and scraper enable the user to haul over pavement and move from one job to another without trucking or freighting. The model has a low center of gravity, a high road clearance that permits easy hauling over ditches and levees, an independent front apron, and a rear apron that wipes the scraper bowl sides clean as the load is dumped. The simple yoke design and absence of overhead structure give the tractor operator a good view of his work. Scraper can be unhitched in a matter of minutes to free tractor for plowing, disking, harvesting and other drawbar work. Cutting edge width for the H-63 is 7 ft; turning radius of tractor and scraper combination is 15 ft 6 in.; weight of scraper, complete with hitch assembly, approximately 7,670 lbs. Scrapers may be had with either single or dual tires. Front wheel assembly may be added so scraper can be operated as a 4-wheel scraper with either crawler or wheel tractors. **American Tractor Equipment Corp., 9131 San Leandro Blvd., Oakland 3 Calif.**

Portable Conveyors

FOUR PORTABLE CONVEYORS, with speed and ease in operation, introduce Fairfield's line of conveyors designed especially for the construction field. These dependable conveyors are fully described and illustrated in Bulletin 450. The all aluminum utility conveyor is one-man-operated, weighs but 100 lbs., and handles sand, gravel, cinders, lime, etc. The light weight troughed belt conveyor—Model 666—is a low cost portable conveyor with a high capacity, designed to handle sand, lime, gravel, crushed stone, ore, etc. The

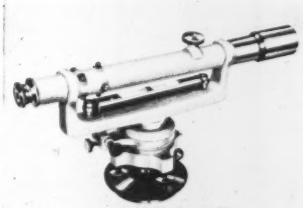
(*Continued on page 91*)

Equipment, Materials & Methods (Continued)

heavy duty troughed belt conveyor is ideal for car unloading direct to trucks. Model 608 handles stone, loose earth, ore, even brick, tile and packages. The power moved troughed belt conveyor will fill the bill for those extra heavy loading and stock piling jobs. The power moved belt car unloader, model 134-B, will give you speed and ease in unloading railroad cars of sand, gravel, etc., to conveyors to trucks. Model 134-B has a guaranteed capacity of 60 to 80 yds of sand or gravel per hour. **The Fairfield Engineering Company, Portable Div., Marion, Ohio.**

Dumpy Level

A MODERATELY PRICED Builder's dumpy level recently designed and manufactured, has been added to the line of Leupold precision instruments. The level is a shorter, more compact instrument and is specially designed for construction and irrigation work. The telescope is 13 in. long with external focusing and with a $1^3/_{16}$ in. objective lens. Achromatic lenses produce a flat field and a magnification of 19 diameters. The level has a spiral screw in the eyepiece for accurately focusing on crosshairs. Its effective aperture is $1^1/_8$ in. with a minimum focus of six ft and a true field of $1^1/_2$ deg. The spirit level, $5^1/_4$ in.



Precision Instrument

in length, is sensitive to 60 sec. of arc per 0.1 in. graduation. The complete instrument weighs $7^3/_4$ lbs. Builder's dumpy level features common to other Leupold levels include the four screw, shifting type leveling head and hermetically sealed matched ball bearings in the center to provide more lasting accuracy. The instrument is finished in baked wrinkle enamel with gunmetal trim. The tripod is sturdily constructed, having solid maple legs, and weighs seven lbs. **Leupold & Stevens Instruments, Inc., Portland, Oregon.**

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By EDMUND ASTLEY PRENTIS and LAZARUS WHITE

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Presentation is made of theoretical considerations of the hydrodynamics of seepage forces, stream erosion, and lateral earth pressures for cofferdams on land and in water. Actual design and construction features are presented by detailed case studies of cofferdams which have come under the authors' supervision. Construction equipment, pumping stations, sheetpiling of wood and steel, bracing systems, excavation methods are among the features described. Actual cases of pitfalls and failures, as well as successes, are given.

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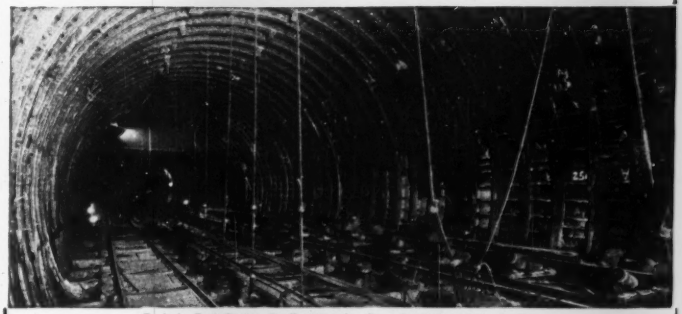

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Equipment, Materials & Methods (Continued)

Chain Saw

A 27 LB, 4 HP, GASOLINE chain saw is announced. Lighter and more powerful, the model 26LCS has more power per pound than any other saw. Fast cutting speed is the result of two unique features; a narrow-kerf chain which does less waste cutting and thus requires less power to drive; plus an efficient Gilmer belt drive which eliminates drive gears that eat up engine power. Perfect balance, with the weight close to the operator's body, plus simple pivot action makes this saw easy to handle on all cuts, whether felling, bucking, undercutting or notching. There's just one simple control, a throttle button on the handle. Automatic centrifugal clutch stops chain when engine idles, and prevents overload when chain binds in cut. Concentric-bowl carburetor permits operation at extreme angles. Just push a button and rotate saw to change from vertical to horizontal cutting positions, the carburetor swivels with the control handle, there are no screws to loosen, no nuts to tighten. Built to stand up under the roughest use, the tough Homelite chain saw has ball and needle bearings at every point of friction. Built-in engine governor keeps engine from racing when saw is out of cut; prevents excessive wear and stresses. Rain and dust proof ignition plus large protected air cleaner makes the engine easy to start in the coldest, wettest weather. **Homelite Corporation, Port Chester, New York.**

New Welding Process

AUTOMATIC HIDDEN ARC WELDING has been limited in application to jobs where the joint to be welded is in position for downhand welding. A process, referred to as "3 o'clock" welding, removes this limitation and extends the advantages of automatic hidden arc welding to jobs where the joint is in positions other than that for down hand welding. This process consists of new welding methods, procedures and equipment wherein the previous difficulties of directing the electrode and retaining flux and molten metal in a joint not lying flat are overcome. With this process the plate being welded may be positioned anywhere from flat to vertical, the joint being horizontal. The process greatly reduces the cost of welding and expands the possibilities for the application of hidden arc techniques. Because joints can be positioned horizontally, welds from both sides of the joint can be made simultaneously. This reduces actual arc time on a given joint by about 50 percent and results in lower direct labor costs. Positioning each weld for downhand welding is eliminated thus reducing handling and set-up time. Other advantages of the process are a minimizing of the effects of distortion and the causes of weld cracking. Tendency for burn through is reduced and back-up strips can be eliminated where two arcs on opposite sides of the work are used. **The Lincoln Electric Company, Cleveland 1, Ohio.**

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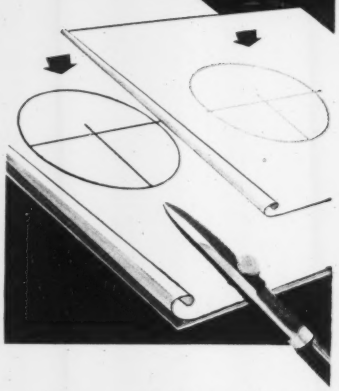

• The renown of Imperial as the finest in Tracing Cloth goes back well over half a century. Draftsmen all over the world prefer it for the uniformity of its high transparency and ink-taking surface and the superb quality of its cloth foundation.

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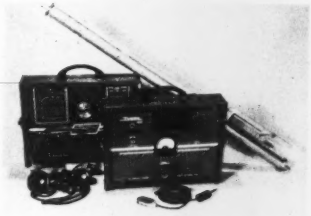
Equipment, Materials & Methods (Continued)

Pipe-Leak Detector

A COMBINATION PIPE-LEAK detector has been introduced. Known as the Model 505-C, the instrument includes all the features of the Model 505 pipe detector, and in addition, is provided with a microphone and an amplifying and filtering circuit for detecting leaks. Compact and easy to operate, the 505-C is an all-purpose instrument and is considered to be essential equipment by many public utility and pipe



Model 505-C

line companies. The detector features an aluminum case and a life-time guarantee. The use of standard long-life batteries assures low cost operation. Additional information on the instrument can be obtained by writing to the **Detectron Company, 5631 Cahuenga Boulevard, Dept. CE, North Hollywood, Calif.**

Traffic Line Spreader

AN IMPROVED SLED-TYPE SPREADER for its controlled-flo-traffic-line paint striper making it possible to lay down lines in fractional widths from two to eight in. is announced. The machine—because of its marked mobility, silence and ease of operation—is particularly adapted to line street crossings, roads, highways, construction projects and traffic safety zones. Gravity-fed and requiring no power unit, it has no hose to blow out, no jets to clean, no pressure tank to worry about, no brush or felt band to maintain or replace and no gas engine or compressor to complicate its operation. Noiseless in operation, the machine throws off no spray dust. Receiving the paint from the gravity line, a distribution apron feeds it evenly to finger rollers which spread the fluid. The machines are used with excellent results on any reasonably smooth surface such as macadam, concrete asphalt or wood. Off-set in operation, it allows the operator a clear view of the line at all times thus eliminating the necessity of straddling the stripe. **Universal Marine & Mfg. Corp., 137 Alexander St., Yonkers 2, N. Y.**

Another *tough* foundation problem solved with DRILLED-IN CAISSONS

Cylinders installed through 60 feet of highly plastic clay and socketed into anorthosite rock.
Puyjalon River crossing abutment supporting plate girder railroad bridge. Cylinders were battered 1:6 both longitudinally and transversally with bridge.
Executed for FRASER-BRACE Engineering Co., Inc.

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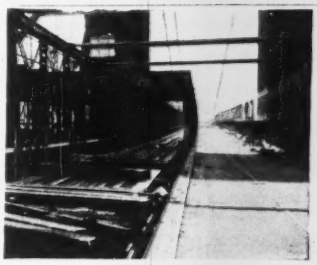

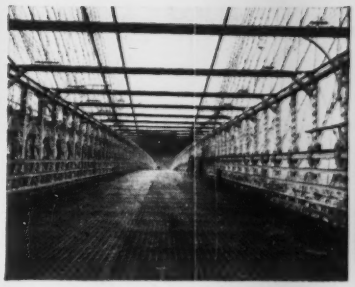

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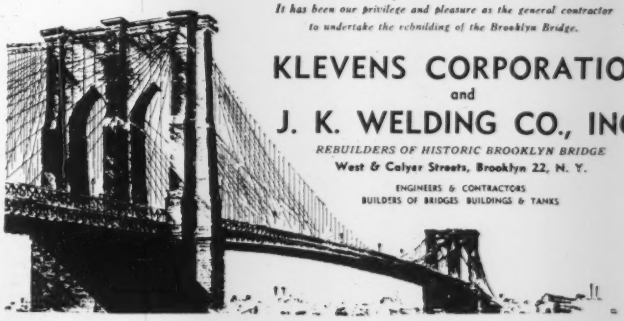

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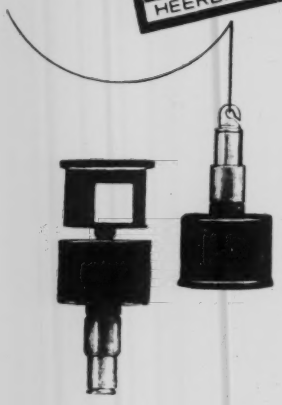

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Pentagonal Prisms or Optical Squares, the size of a plumb bob and the weight of a jack knife, can be kept on your watch chain.

The Optical Square is a handy tool for checking on location, for alignment, and for laying out right angles. Speedily used as a hand level, it has an accuracy in leveling of 1 inch in 200 feet. The instrument is available in single and double prisms.

For further detailed information on the operation and use of Optical Squares call or write for Booklet CVE 7

Complete repair and servicing facilities by factory specialists.

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Equipment, Materials & Methods (Continued)

Break-Resistant Cutting Blade

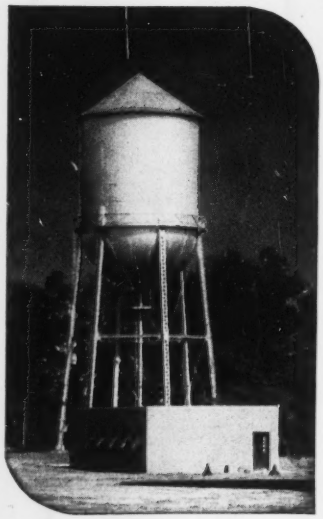
THE "B-R" (BREAK-RESISTANT) abrasive blade is one of the most amazing blade products ever produced in masonry cutting. Dropping, twisting in the cut, or bending will not damage the blade. It is manufactured in layers of glass fiber cloth impregnated with resins and silicon carbide. This material is then pressed together under hydraulic pressure and processed in kilns where the temperature is scientifically controlled to insure a resilient and tough blade able to take amazing

"B–R" Blade

punishment. Its most effective performance is in the softer range of materials such as limestone, sandstone, light aggregate concrete products and dry press refractories, transite, etc. The "B-R" blade gives outstanding efficiency on small hand-power tools where it is impossible to maintain a true cutting level. This condition causes the blade to bend or twist in the cut resulting in breakage with the ordinary abrasive blade. **Clipper Manufacturing Company, Dept. CE, 2800 Warwick, Kansas City 8, Mo.**

Automatic Welding and Positioning Equipment

A LINE OF AUTOMATIC WELDING and positioning equipment designed for the rebuilding of worn equipment parts such as tractor idlers and rollers, shovel rollers and shafts, crusher cones, etc., is announced. The equipment, using proper steel alloy welding rod, makes it possible to rebuild these worn parts at a fraction of new part replacement cost and assures a longer than new part wear in many cases. The equipment utilizes the submerged arc principle of automatic welding, and an alternating current transformer type welding machine in conjunction with a work positioner capable of handling conical or cylindrical equipment parts which weigh up to 750 lbs and whose diameter is not less than 4 in. or greater than 36 in. All work is held on centers, which assures a concentric buildup of the worn part. **Mir-O-Col Alloy Co., 312 North Ave. 21, Los Angeles 31, Calif.**



THIS TIME IT'S

NACOGDOCHES, TEXAS

Over in the prosperous timber and agricultural belt of east Texas, the city of Nacogdoches is looking and planning for further growth. Needing more water, municipal officials called in Layne and ordered the installation of another deep well and pump unit, —the third since 1925. With this new unit in operation, the city now has a greater supply of water than is presently needed.

These three Layne installations extending back for more than a quarter century, have had every opportunity of failing,—or proving their value in high efficiency, long life and absolute dependability.

Congratulations to Nacogdoches for the continued and exclusive use of the world's finest wells and pumps.

LAYNE & BOWLER, INC.
General Offices, Memphis 8, Tenn.

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Layne's new catalog on Short Coupled Service Pumps will be sent on request. It fully illustrates the many practical applications of these wonderfully efficient all purpose pumps.

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The swiftest, surest dewatering method is also the simplest and most economical. "Complete's" patented fluted tube wellpoints combine compactness with lightness and strength—enable you to handle tougher jobs at lower cost—keep you on firm ground always. Write, wire or phone for estimates—we have the equipment, experience and personnel.

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Literature Available

WIRE ROPE—The recommendation booklet, "The Right Rope for the Job," covers all industries—construction, mining, petroleum, marine—even aircraft control cable. There are numerous photographs, plus listings of equipment and the types of wire rope that should be used. **American Steel & Wire Company, 842 Rockefeller Bldg., Cleveland 13, Ohio**

WROUGHT IRON PIPE—A 4-page bulletin that contains the most frequently required data on wrought iron pipe has been published and will assist technicians in their design and specification work. Consolidated tables list size and dimensional data for both standard and extra strong pipe. All official specifications for wrought iron are listed. Chemical composition, properties, general applications and special applications are condensed into one page. Also included is a radiant heating conversion chart and a formula for use in designing snow melting systems. **Engineering Service Department, A. M. Byers Company, Pittsburgh, Pa.**

PLASTER-MORTAR MIXERS—A catalog recently released provides a simple method of comparing construction features, dimensions and capacities of various types and sizes of plaster-mortar mixers. Printed in attractive colors, the bulletin contains many photographs depicting exclusive Kwik-Mix features along with schematic drawings listing the detailed dimensions of each machine. **Kwik-Mix Company, Port Washington, Wis.**

DIESEL ENGINE—The two-color Bulletin 183, contains construction and operation features of the Nordberg four-cycle, cylinder and recently introduced two-cylinder, vertical, mechanical injection, Type 4FS diesel engine. The bulletin illustrates various engine applications and gives kilowatt ratings and pumping capacities of the different models. It also pictures all main engine parts and gives their particular specifications. **Nordberg Mfg. Co., Milwaukee 7, Wis.**

ROBOT OPERATORS—A comprehensive coverage of modern automatic operating equipment for doors and gates is announced. The literature, by means of simply-written descriptive and explanatory text, plus free use of pictures and diagrams, shows what has been done in this field in the past twenty years, and what makes the use of automatic operating devices constantly more necessary to modern living and working. **Robot Appliances, Inc., Dearborn, Mich.**

ENGINES—A 16-page booklet, entitled "Cummins Powered Euclid Equipment," describes five Cummins diesels and eleven standard models of Euclid equipment they power. **Cummins Engine Company, Inc., Columbus, Indiana.**

PROTECT YOUR PROJECTS with a Strong, Durable Fence!

Fence built with Koppers Pressure-Creosoted Posts and heavy wire.

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Koppers Posts are made from sound, strong wood. They are pressure-treated with creosote to protect them against decay and termites. The pressure-treatment method is identical with that used by Koppers to protect utility poles, foundation and marine piles, and the timber in highway bridges. Koppers Posts give decades of service, making them extremely economical. They require no painting, and they never rust.

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Koppers Posts, when treated with creosote, have a dark, warm color. They blend nicely with most surroundings. However, if you prefer wood posts that are easily paintable, Koppers will use a preservative other than creosote.

All Sizes Available

Koppers manufactures posts in any size you want — in any diameter, in any height. Besides fence posts, Koppers makes many types of treated highway posts. Write us for further information.

KOPPERS COMPANY, INC., Pittsburgh 19, Pa.

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Top photograph shows marked disintegration and almost complete failure of a large Municipal Swimming Pool located in a Virginia city.

This picture was taken after Cement Gun Company crews had begun restoration with "Gunite." Reinforcing mesh is in place on the floor and chipping and scaling operations are taking place on the sidewalks.

Lower photograph shows the complete "Gunite" job before water was put back in the pool. This job is typical of what Cement Gun Company can do with disintegrated concrete and masonery using "Gunite."

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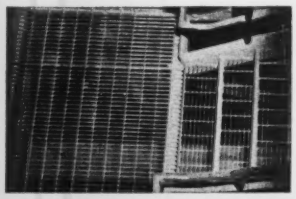

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1819 10th St., Oakland 20, Calif.

Literature Available (Continued)

TIRE CONSERVATION—Containing a wealth of easy-to-understand information on the subject of tire conservation, an 8-page booklet "9 Ways to Get More Miles Out of Truck Tires" has been published. Nine methods to have tires provide their maximum service are given. Text of each of the subjects is short, informative and illustrated. A truck tire load and inflation table and a dual spacing table are among the features. **The B. F. Goodrich Company, Akron, Ohio.**

GATES—In a folder just published, drainage and irrigation engineers will find a quick practical answer to problems of controlling or regulating water. "Water Control Problems Vanish When You Count to 7" tells how Armco gates meet water control needs in seven days. Easy operation, long service life, adaptability, and low cost are listed as several of their features which have resulted in the wide use of Armco gates in irrigation, flood control, drainage, sewage and water supply. Photographs show typical applications of some of the twenty-seven different models of Armco gates. **Armco Drainage & Metal Products, Inc., General Offices, Middletown, Ohio.**

PORTABLE ROLLER—An attractive four-color catalog No. 350, presenting the new model portable roller is available. Complete specifications are given, together with detailed description and photos of the many construction and operation features—some of which are: hydraulic steering, constant-mesh transmission, spur gear final drive, variable weight compression roll, and towing hitch with built-in hydraulic jack. **The Galion Iron Works & Mfg. Co., Galion, Ohio.**

CRAWLER MACHINE—An illustrated catalog on the ¾ yd series, crawler mounted shovel, crane, dragline, clamshell and hoe is announced. The catalog features the heavy duty design and construction of this convertible machine for excavating, erecting and material handling. Machinery assemblies, parts and attachments are shown in pictures and described in detail. **Bay City Shovels, Inc., Bay City, Mich.**

MOTO PAVER—Bulletin MP-49, describes the Moto-Paver, a self-contained, single-unit machine that accomplishes the complete mixing and laying job in one continuous operation. Special features, specifications and on-the-job photos are included. **Hetherington & Berner Inc., 701-745 Kentucky Ave., Indianapolis 7, Ind.**

CLAMPS—Bulletin 151 describes and illustrates Pacific clamp set-ups for all standard curb jobs and also shows special applications. Typical installations are also shown. **Pacific Engineering Sales Co., 215 West Fifth St., Los Angeles 13, Calif.**

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TIDE GATES

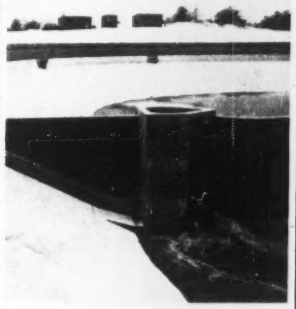

Fig. B-144-A

One of Two 48" Type M Gates installed in Ft. Stanton Park Reservoir, Washington, D. C., to maintain direction of flow. See Feb. 22, 1944, issue Engineering News Record for story about this project.

BROWN & BROWN, INC.
LIMA, OHIO, U. S. A.

Literature Available (Continued)

CENTRAL MIXING—"12 Ways To Set Up for Central Mixing" is the name of a 4-page pamphlet just issued. It is designed to show the economies and increased production that can be gained through pre-mixing and delivery of concrete in nonagitating equipment. Twelve different types of central mixing plants are illustrated and briefly described. Ask for Pamphlet No. 111, **Dumpcrete Division, Maxon Construction Company, Inc., 131 N. Ludlow St., Dayton 2, Ohio**

MIXER—A 16-S Dandie concrete mixer catalog has been released. The bulletin accurately describes and illustrates all recent improvements made on the new three-bag capacity machine. Printed in attractive colors, the catalog explains the improved construction features of the Model 16-S. Schematic drawings, listing the detailed dimensions of the 16-S Dandie, also are included in the catalog along with specifications on the extension track and tower loader attachments. Both of these units are included in the optional equipment listing with the batch chopper, water pump, auxiliary water tank, swivel chute and electric motor. **Kwik-Mix Company, Port Washington, Wis.**

CENTRIFUGAL PUMP—Bulletin No. 5004-A covers the latest developments in a line of single stage, split case centrifugal pumps. All pumps shown in the bulletin are furnished for direct connection to electric motors, steam turbine, gasoline engines, or with belt drive from any source of power. A performance table printed in various colors simplifies the selection of any individual unit to meet specific requirements for capacity and head. Illustrations in color of important elements of construction and detailed specifications including dimension tables give a complete understanding of these pumps. **The Deming Company, Salem, Ohio.**

MASTIC CAULKING AND POINTING—A 12-page brochure containing detailed and short specifications for mastic application on masonry construction, has been published. Attractively illustrated by photographs and drawings, "Mastic Caulking and Pointing" is a complete discussion of the subject. The specifications, indexed for handy reference, cover 7 pages and include caulking, pointing, bedding and buttering. **The Tremco Manufacturing Company, Cleveland 4, Ohio.**

DIESEL CRAWLER TRACTORS—An International TD-9 diesel crawler tractor catalog has just been published. A two-color presentation, the catalog contains detailed specifications and information on how the TD-9 develops and applies its 40.5 drawbar horsepower. Several varied job application scenes appear in the publication along with information on construction and operating features. The catalog may be obtained by requesting form CR-313-A from the **International Harvester Company, 180 North Michigan Ave., Chicago 1, Ill.**

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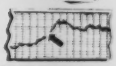

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CHICAGO, ILL., 33 No. LaSalle Street
FLORENCE, ALA., South Court Street

Literature Available (Continued)

FLOTATION SEPARATOR BULLETIN—A bulletin describing and illustrating the Sveen Pedersen separator has just been issued. The patented flotation saveall is used for removal of suspended solids and partial removal of B.O.D. (biological oxygen demand) from waste water. Write for Bulletin FS-29. **Sveen Pedersen Sales Corporation, 35-21 Eleventh St., Long Island City 6, N. Y.**

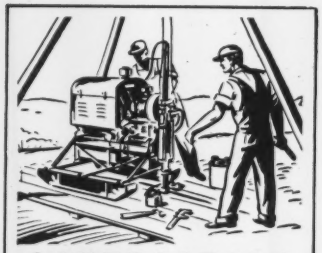
CONCRETE CRIBBING—Complete information about concrete cribbing is contained in an 8-page illustrated brochure now available. The publication presents a case-history of both open and closed-face cribbing. Drawings show typical wall sections of varying lengths. Engineering specifications and instructions are also included, together with several photos of cribbing manufacture and actual installations. **Universal Concrete Pipe Co., 297 S. High St., Columbus, Ohio.**

SUBDRAINAGE SYSTEMS—A folder entitled, "How to Stop Excessive Maintenance at the Source," shows how Armco subdrainage systems get at the cause of the trouble. The illustrated folder describes how light weight Armco perforated pipe is especially adapted for highway and railroad loading conditions; how it admits water freely without danger of clogging; and how the long 20 ft. pipe sections can be quickly and economically installed. **Armco Drainage & Metal Products, Inc., General Offices, Middletown, Ohio.**

CLAMSHELL BUCKETS—A bulletin containing 42-pages of practical and useful information on the maintenance and care of clamshell buckets has just been published. Included are suggestions on the proper use of the buckets, with a list of common abuses to be avoided. Of particular interest to operating men is the section on bucket lips. There are practical tips on prolonging bucket cable life and diagrammed instructions for the replacement of component parts. Ask for Bulletin No. 2373, **Blaw-Knox Division of Blaw-Knox Company, Farmers Bank Bldg., Pittsburgh 22, Pa.**

MOTO-MIXERS—A bulletin on the complete line of improved Rex hi-discharge moto mixers is now being distributed. The improvements which increase the efficiency of the machines are shown and described in detail. Many features are explained in the book. **Chain Belt Company, Dept. Pr, 1600 West Bruce St., Milwaukee 4, Wis.**

SEWERS—An illustrated folder, "Help Prevent Sewer Failures Before They Happen," shows how Armco corrugated metal sewer structures can be used to meet practically all service conditions and have ample strength for long service. The folder also points out that Armco sewers are easy to install and offer a quick, easy and economical means of repairing failing sewers. **Armco Drainage & Metal Products, Inc., General Offices, Middletown, Ohio.**



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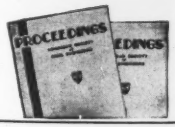

PROCEEDINGS AVAILABLE

The following papers, printed as Proceedings Separates, may be ordered on the basis of summaries given in this and previous issues of CIVIL ENGINEERING. Discussions of these papers will be received, as in the past, for a period of five months following the date of issue. A summary of each paper appears in several consecutive issues; other titles will be added every month, as they become available. Use the convenient order form on page 100.

Summarized in Earlier Issues

61. Structural Damping in Suspension Bridges, by the late Friedrich Bleich and L. W. Teller.

62. The New Towns Program in Great Britain, by T. C. Coote.

63. National Geodesy—Status and Planning, by Leo Otis Colbert.

D-8. Discussion of Paper, **Floating Tunnel for Long Water Crossings,** by Charles E. Andrew.

D-11. Discussion of Paper, **Long-Term Storage Capacity of Reservoirs,** by H. E. Hurst.

D-16. Discussion of Paper, **Pavement Bearing Capacity Computed by Theory of Layered Systems,** by Guthlac Wilson and G. M. J. Williams.

D-19. Discussion of Paper, **Flood-Control Operation of Tennessee Valley Authority Reservoirs,** by Edward J. Rutter.

D-23. Discussion of Paper, **Influence of Heavy Loads on Pavement Design Trends,** by K. B. Woods.

64. Planning the National Capital: Objectives and Problems of Attainment, by Ulysses S. Grant III.

65. National Topographic Mapping, by W. E. Wrather.

66. Lateral Forces of Earthquake and Wind, by a Joint Committee of the San Francisco, Calif., Section, ASCE, and the Structural Engineers Association of Northern California.

D-13. Discussion of Paper, **Reinforced Concrete Skewed Rigid-Frame and Arch Bridges,** by Maurice Barron.

D-18. Discussion of Paper, **Successive Approximations for Beams on an Elastic Foundation,** by E. P. Popov.

D-21. Discussion of Paper, **Maximum Load Capacity of Bailey Bridges,** by Robert B. Stegmaier, Jr.

Third Notice

67. Model and Prototype Studies of Sand Traps, by Ralph L. Parshall. Two successful methods of controlling the deposition of waterborne gravel and sand in power and irrigation canals are discussed and illustrated. The vortex tube and riffle deflector have proved effective in trapping the bed load in actual installations as well as in laboratory tests. The design and operation of these devices is outlined and their relative efficiencies are compared. (Available June 1.)

68. International Cartography, by Robert H. Randall. Modern transportation and communication facilities have made it imperative to secure cartographic cooperation on a much wider basis than in the past. Attempts to secure such cooperation among the nations of the world are described. The purposes, methods of operation, and accomplishments of several international cartographic organizations are given as well as details of United Nations participation in the planning. (Available June 1.)

69. Valuation and Depreciation Related to Income Tax, by Maurice R. Scharff. This paper supplements a previous paper by suggesting a procedure by which income tax can be taken into account in economic comparisons of engineering projects and in valuations of public utility property, based upon present worth of earning power. In effect income tax is treated as an additional fixed charge on investment. Algebraic formulas are presented and illustrated by examples. (Available June 1.)

70. Regime Theory for Self-Formed Sediment-Bearing Channels, by T. Blench. Major river diversions for irrigation have proceeded in India since 1890 under conditions of (1) sediment-laden water, (2) excavated canal boundaries of erodible alluvium, and (3) very flat country. Rational formulas have been developed for the final self-adjusted dimensions of such canals. The formulas fit and amplify the framework of rigid-boundary hydraulics. Applications are made to the consequences of interfering with river regime. (Available June 1.)

71. Rectification of the Papaloapan River in Mexico, by Reynaldo Schega. The Papaloapan River in Mexico is undergoing rectification by means of six cutoffs, as a first major step in a comprehensive development of its basin for flood control, navigation, and power production, undertaken by the government of Mexico. The system of cutting off river bends by excavating pilot cuts that the river subsequently enlarges into full-sized channels is patterned after that adopted on the Mississippi River. The status of the project two years after the pilot cuts were dug is presented, illustrated by aerial photographs. (Available June 1.)

D-24. Discussion of Paper, **Buckling of Rigid-Jointed Plane Trusses,** by N. J. Hoff, Bruno A. Boley, S. V. Nardo, and Sara Kaufman. The original paper, published in June 1950, gave rigorous methods of calculating the elastic restraint of adjacent members on a compression member and also of determining the effect of gusset plates on rigidity. Discussers are: Jacob Karol; Alfred S. Niles; Thomas C. Kavanagh; George Winter and Oliver G. Julian; N. J. Hoff, Bruno A. Boley, S. V. Nardo, and Sara Kaufman. (Available June 1.)

D-27. Discussion of Paper, **Plasticity of Metals—Mathematical Theory and Structural Applications,** by D. C. Drucker. The original paper, published in August 1950, emphasized the importance of plasticity in elastic design and illustrated the use of elementary plastic analysis. Discussers are R. W. Steed, Jacob Karol, S. K. Ghaswala, and D. C. Drucker. (Available June 1.)

D-28. Discussion of Paper, **Retrogression on the Lower Colorado River After 1935,** by J. W. Stanley. The original paper, published in August 1950, discussed the control of floods and sediment deposition in the lower Colorado River made necessary by the construction of Hoover Dam. Discussers are: T. Blench, E. W. Lane, and J. W. Stanley. (Available June 1.)

Second Notice

72. Design of Large Coal Bunkers, by Paul Rogers. Design procedure is presented

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for large capacity coal bunkers. Coal pressures by the shallow bin formula and by modified deep bin formulas are reviewed, pressures on inclined wall analyzed, and values tabulated. Bunker walls are presented as flexible plates and inward forces analyzed. Unbalanced forces due to unsymmetrical layouts are investigated. The paper advocates design by continuity for the stiffeners, and the inclusion of the bunker plates in the design of stiffeners is emphasized. Several illustrations and tables are included to facilitate quick and economical design. (Available July 1.)

73. Health Implications of Air Pollution, by J. J. Bloomfield. The need for control of air pollution is especially urgent in view of the increasing industrial activity with attendant pollution of the atmosphere. Studies have shown a definite relationship of air pollution to health. The study of the Donora smog of October 1948, during which 6,000 persons were affected (20 of them fatally) confirmed the acute threat of air pollution and pointed the way to consideration of long-range, or chronic effects. Reduction of the pollution load is not always economically feasible with available devices, but research and restriction should aid in the solution of the problem. The engineer in industry can play an active part in this rapidly expanding field. (Available July 1.)

74. Acceptable Standards for Natural Waters Used for Bathing, by Charles R. Cox. Increasing interest in the public health aspects of bathing water quality has led to a study of standards suitable for the control of these waters. Quantitative bacteriological standards are difficult to apply without supplementary sanitary surveys and the exercise of seasoned administrative judgment. Methods of evaluating pollution have not developed sufficiently to permit assuming absolute standards. The connection between pollution of bathing waters and illness of the rising population has not been investigated thoroughly. (Available July 1.)

75. Base Course Drainage for Airport Pavements, by Arthur Casagrande and William L. Shannon. Observations on a number of airfields are described illustrating the principal causes for the saturation of base courses of airfield pavements. A theoretical analysis of the drainage of saturated base courses is presented and working formulas are recommended. Laboratory tests on fluid models and full-scale field tests are described and their results compared with the theoretical formulas. The recommended design procedure is illustrated by means of an example. (Available July 1.)

76. Model Tests Using Low-Velocity Air, by James W. Ball. The use of low-velocity air testing to solve flow problems pertaining to hydraulic conduit systems and equipment is presented. How this method of testing may be used as an inexpensive expedient in obtaining complete or partial solutions to hydraulic problems is outlined. Limiting velocities, advantages, disadvantages, precautions, comparison with hydraulic tests, and specific examples are discussed. (Available July 1.)

D-25-K. Discussion of Paper, **Uplift Pressures in Concrete Dams,** by Kenneth B. Keener. The original paper, published in June 1950, described the installation and location of equipment used to observe uplift in concrete dams and gave methods of relieving this uplift. Discussers are: Ross M. Riegel, William P. Creager, A. Warren Simonds, Fairfax D. Kirn, Serge Leliavsky Bey, A. M. Davison, Duff Abrams, and Kenneth B. Keener. (Available July 1.)

D-29. Discussion of Paper, **Sedimentation Studies at Conchas Reservoir in New Mexico,** by D. C. Bondurant. The original paper, published in August 1950, presented data on the form and extent of sediment deposits at Conchas Reservoir and emphasized the importance of considering sedimentation in reservoir design. Discussers are: T. Blench and D. C. Bondurant. (Available July 1.)

D-32. Discussion of Paper, **Effect of Skew Angle on Rigid-Frame Reactions,** by Walter C. Boyer. The original paper, published in September 1950, presented methods of analysis of the skewed rigid-frame bridge that reduce the arduous labor of design of such structures. Discussers are: D. A. Nettleton, Maurice Barron, and Walter C. Boyer. (Available July 1.)

First Notice

77. Buckling Stresses for Flat Plates and Sections, by Elbridge Z. Stowell, George J. Heimerl, Charles Libove, and Eugene E. Lundquist. The results of extensive studies in the buckling of flat unstiffened plates conducted in the field of aeronautics are surveyed. The single plate loadings of compression and shear are considered as well as integral flat-plate loadings of compression only. The buckling stresses are given in the form of a nondimensional chart for the elastic stress range. (Available August 1.)

78. River Channel Roughness, by Hans A. Einstein and Nicholas L. Barbarossa. The total friction developed on the alluvial bed of a natural river can be described as the sum of a "surface drag" and of a "shape resistance." The surface drag may be determined from conventional friction formulas but the shape or bar resistance is given as a function of the sediment transport. An easily applicable relationship is presented in the form of a graph, from which the shape resistance can be determined. This curve has been derived from a wide variety of measurements in natural rivers and is generally applicable to natural rivers. (Available August 1.)

79. Stage Predictions for Flood Control Operations, by Ralph E. King. The problems relative to the prediction of stages in the lower Mississippi River Valley during flood periods are the subject of this paper. The development of various forecasting techniques and the advantages and limitations of these techniques with respect to use on the Mississippi River are briefly outlined. Methods used by the Stage Prediction Section of the Mississippi River Commission are explained, with emphasis being given to the method used for reaches which are influenced by inflows from major tributaries. Conclusions as to the type of forecasting procedure necessary to obtain reliable stage predictions on the lower Mississippi River are presented. (Available August 1.)

80. Mississippi River Valley Geology Relation to the River's Regimen, by Harold N. Fisk. A brief description of the geology of the alluvial valley of the lower Mississippi River is given and major changes in stream activity are described. The nature and geological development of the alluvial deposits are discussed and the close adjustment between these bed and bank materials and channel characteristics emphasized. Alluvial plain features show that this adjustment has been maintained since the sea reached its present level several thousand years ago. During this period the river has developed and abandoned several meandering courses. The existing Atchafalaya-Mississippi relationships suggests an early stage in the diversion of the river to a new course. (Available August 1.)

81. Petenwell Hydroelectric Project, by E. Montford Fucik. This project, located on the Wisconsin River, involved unusual design problems because of the 100 ft deep sand foundation. The spillway and powerhouse are founded on this sand, and the basic design criteria, as well as the cross sections of the structures are given. Recorded water pressures under the completed structures, and comparisons of model test and prototype scour patterns downstream from the spillway, are shown. The earth dams, built of sand, are described, and recorded seepage lines are compared with the flow net studies. The use of hydraulic spillway gate hoists is also described. (Available August 1.)

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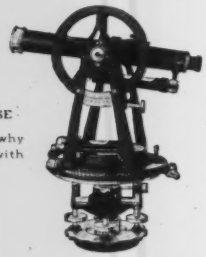

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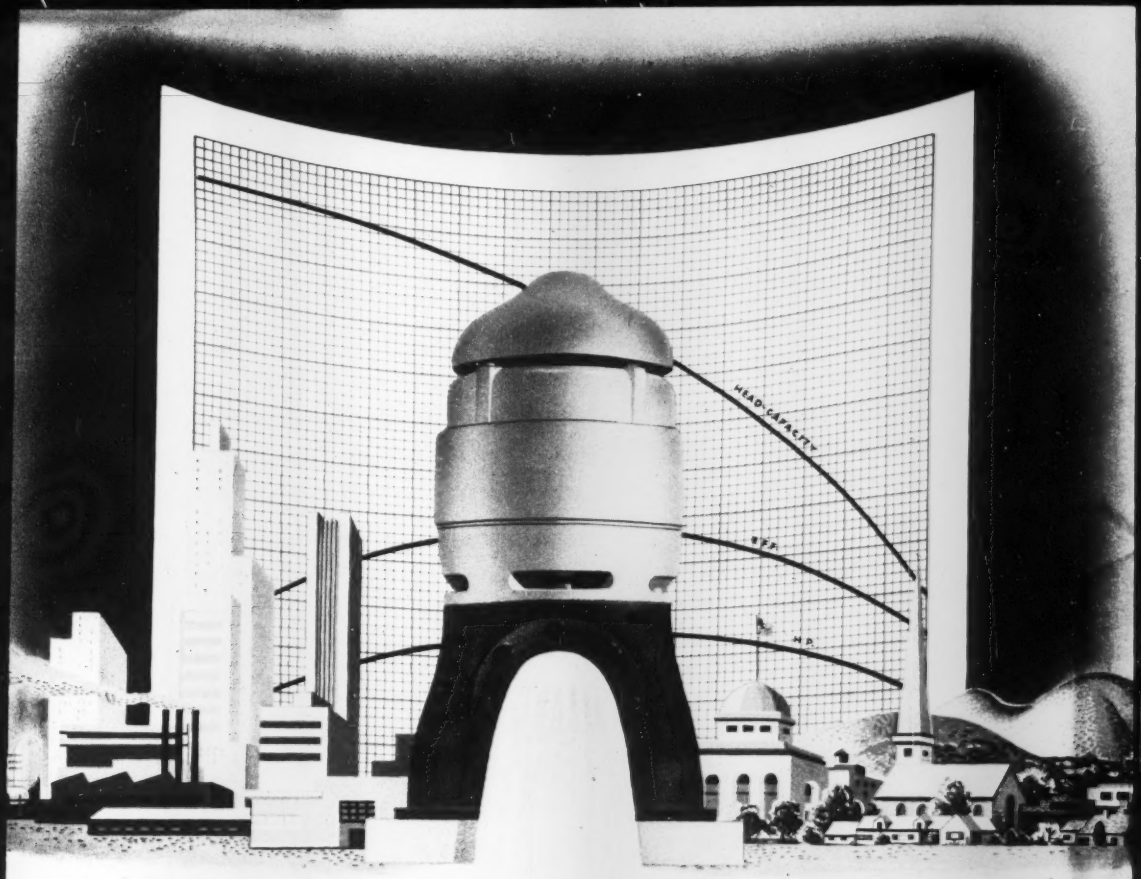

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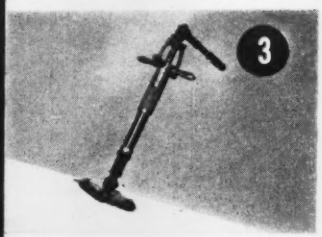

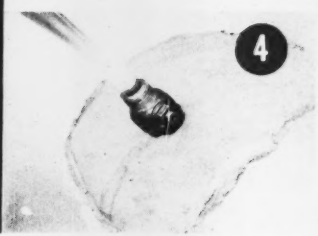

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